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THE PHILIPPINE
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VOL. 75 MAY, 1941 No. 1

AMPHIBIANS AND REPTILES FROM SOUTHEASTERN CHINA [1]

By J. LINSLEY GRESSITT

Of the Lingnan Natural History Survey and Museum,
Lingnan University, Canton, China

ONE PLATE

The following notes and descriptions are based entirely upon a collection of amphibians and reptiles, numbering over nine-hundred specimens, made by me during the summer of 1936, in the adjacent portions of Kwangtung, Kiangsi, and Fukien provinces in the eastern part of South China. The collection is permanently deposited in the Museum of Vertebrate Zoology of the University of California in Berkeley. The numbers by which the specimens are listed are those of the Museum of Vertebrate Zoology (M. V. Z.). The collection is interesting as being from a part of China that has been very little collected herpetologically. For this reason a number of species can be added to those known from the three provinces visited, as is demonstrated by the three lists of the species collected in Kiangsi, Kwangtung, and Fukien Provinces, respectively, that follow—the new provincial records being asterisked. The list for Kiangsi Province, where the largest number of species was collected, is particularly striking, in that nearly one-half of the species are new to the province. After the provincial lists, the species are listed according to the altitudinal ranges in which they were collected to indicate something of the life zoning in this region. This list is followed by the annotated list of species.

---

[1] Contribution from the Lingnan Natural History Survey and Museum.

52987

The collection numbers 63 species in all, including 1 newt (salamander), 1 toad, 18 frogs, 5 burrowing frogs, 6 lizards, 25 snakes, and 7 turtles. Forty-one species were collected in Kiangsi Province, 40 in Kwangtung Province, and 32 in Fukien Province. Of the 63 species, 1 has already been described as a new species: a snake, *Natrix boulengeri* Gressitt,[2] from Kwangtung and Kiangsi Provinces. The writer has also published a brief account of the trip, together with a map and an annotated list of localities at which specimens were collected.[3]

An expression of appreciation is extended to the late Dr. Joseph Grinnell, Dr. Jean M. Linsdale, Mr. Clifford H. Pope, and Dr. Alice M. Boring for their cooperation and advice in connection with this study, and also to the Rev. A. H. Page, the Misses Louise and Dorothy Campbell, Mr. and Mrs. David M. Campbell, the Rev. and Mrs. E. S. Burket, the Rev. and Mrs. Arthur S. Adams, and others of the South China Baptist Mission; and Prof. and Mrs. W. E. Hoffmann, Dr. Franklin P. Metcalf, and Dr. and Mrs. F. A. McClure of Lingnan University, Canton, for extensive aid and kindness during the trip.

SPECIES COLLECTED IN KIANGSI PROVINCE

[Single asterisks are new provincial records; double asterisks mark new species.]

1. *Bufo melanostictus.*
2. *Hyla chinensis.*
*3. *Rana adenopleura.*
4. *Rana fukiensis.*
5. *Rana guentheri.*
6. *Rana japonica.*
*7. *Rana kuhlii.*
*8. *Rana latouchei.*
9. *Rana limnocharis.*
10. *Rana nigromaculata reinhardti.*
*11. *Rana schmackeri.*
12. *Rana spinosa.*
*13. *Staurois ricketti.*
*14. *Rhacophorus leucomystax.*
15. *Rhacophorus dennysi.*
*16. *Microhyla butleri.*
*17. *Microhyla heymonsi.*
18. *Microhyla ornata.*
*19. *Platysternon megacephalum.*
20. *Trionyx sinensis.*
21. *Gekko subpalmatus.*
22. *Eumeces chinensis.*
*23. *Sphenomorphus indicus.*
24. *Natrix æquifasciata.*
**25. *Natrix boulengeri.*
26. *Natrix percarinata.*
27. *Natrix piscator.*
*28. *Natrix sauteri.*
29. *Natrix stolata.*
*30. *Pseudoxenodon bambusicola.*
31. *Opisthotropis latouchii.*
*32. *Opisthotropis maxwelli.*
*33. *Zaocys dhumnades montanus.*
34. *Ptyas korros.*
35. *Eurypholus major.*
36. *Holarchus formosanus.*
37. *Calamaria septentrionalis.*
38. *Enhydris chinensis.*
*39. *Enhydris plumbea.*
40. *Bungarus multicinctus.*
41. *Trimeresurus mucrosquamatus.*

[2] Proc. Biol. Soc. Wash. 50 (1937) 125–128.

[3] Lingnan Sci. Journ. 16 (1937) 439–445.

SPECIES COLLECTED IN KWANGTUNG PROVINCE

[Single asterisks are new provincial records; double asterisks mark new species.]

1. *Pachytriton brevipes.*
2. *Bufo melanostictus.*
3. *Hyla chinensis.*
4. *Rana guentheri.*
5. *Rana japonica.*
6. *Rana limnocharis.*
7. *Rana tigerina rugulosa.*
8. *Rana spinosa.*
9. *Rhacophorus leucomystax.*
10. *Kaloula pulchra.*
*11. *Microhyla heymonsi.*
12. *Microhyla ornata.*
13. *Microhyla pulchra.*
14. *Platysternon megacephalum.*
15. *Cyclemys trifasciata.*
*16. *Clemmys mutica.*
17. *Geoclemmys reevesi.*
18. *Ocadia sinensis.*
19. *Trionyx sinensis.*
20. *Gekko subpalmatus.*
21. *Hemidactylus bowringii.*
22. *Gonocephalus lepidogaster.*
23. *Ateuchosaurus chinensis.*
24. *Eumeces chinensis.*
25. *Natrix annularis.*
**26. *Natrix boulengeri.*
27. *Natrix percarinata.*
28. *Natrix piscator.*
29. *Natrix stolata.*
*30. *Opisthotropis maxwelli.*
31. *Ptyas korros.*
32. *Ptyas mucosus.*
33. *Eurypholus major.*
34. *Holarchus violaceus.*
35. *Enhydris chinensis.*
36. *Boiga multomaculata.*
37. *Bungarus multicinctus.*
38. *Naja naja atra.*
39. *Amblycephalus kuangtungensis.*
40. *Trimeresurus albolabris.*

SPECIES COLLECTED IN FUKIEN PROVINCE

[Single asterisks are new provincial records.]

1. *Bufo melanostictus.*
2. *Hyla chinensis.*
3. *Rana adenopleura.*
4. *Rana guentheri.*
5. *Rana japonica.*
6. *Rana limnocharis.*
*7. *Rana livida.*
8. *Rana tigerina rugulosa.*
9. *Rana schmackeri.*
10. *Rana spinosa.*
11. *Rana taipehensis.*
12. *Œidozyga lima.*
13. *Rhacophorus dennysi.*
14. *Rhacophorus leucomystax.*
15. *Microhyla pulchra.*
16. *Microhyla ornata.*
17. *Microhyla heymonsi.*
18. *Clemmys bealei.*
19. *Trionyx sinensis.*
20. *Gonocephalus lepidogaster.*
21. *Eumeces chinensis.*
22. *Sphenomorphus indicus.*
23. *Natrix percarinata.*
24. *Natrix piscator.*
25. *Natrix sauteri.*
26. *Natrix stolata.*
27. *Eurypholus major.*
28. *Opisthotropis maxwelli.*
29. *Enhydris chinensis.*
30. *Enhydris plumbea.*
31. *Boiga multomaculata.*
32. *Trimeresurus albolabris.*

ALTITUDINAL LISTS OF SPECIES

AT ALTITUDES UNDER 100 METERS

Bufo melanostictus.
Rhacophorus leucomystax.
Kaloula pulchra.
Cyclemys trifasciata.
Clemmys mutica.
Geoclemys reevesi.
Ocadia sinensis.
Ateuchosaurus chinensis.
Ptyas mucosus.
Naja naja atra.
Boiga multomaculata.

AT ALTITUDES FROM 175 TO 500 METERS

Bufo melanostictus.
Hyla chinensis.
Rana guentheri.
Rana limnocharis.
Rana tigerina rugulosa.
Rana taipehensis.
Œidozyga lima.
Rhacophorus leucomystax.
Microhyla ornata.
Microhyla pulchra.
Trionyx sinensis.
Clemmys bealei.
Hemidactylus bowringii.
Eumeces chinensis.
Gonocephalus lepidogaster.
Natrix æquifasciata.
Natrix percarinata.
Natrix piscator.
Natrix sauteri.
Calamaria septentrionalis.
Ptyas korros.
Ptyas mucosus.
Enhydris chinensis.
Enhydris plumbea.
Naja naja atra.
Boiga multomaculata.
Bungarus multicinctus.
Trimeresurus albolabris.

AT ALTITUDES FROM 540 TO 860 METERS

Triturus orientalis.
Bufo melanostictus.
Hyla chinensis.
Rana adenopleura.
Rana fukiensis.
Rana guentheri.
Rana japonica.
Rana kuhlii.
Rana latouchii.
Rana limnocharis.
Rana livida.
Rana nigromaculata.
Rana reinhardti.
Rana schmackeri.
Rana spinosa.
Staurois ricketti.
Rhacophorus dennysi.
Rhacophorus leucomystax.
Microhyla heymonsi.
Microhyla ornata.
Trionyx sinensis.
Platysternon megacephalum.
Gekko subpalmatus.
Hemidactylus bowringii.
Gonocephalus lepidogaster.
Sphenomorphus indicus.
Eumeces chinensis.
Natrix æquifasciata.
Natrix annularis.
Natrix boulengeri.
Natrix percarinata.
Natrix piscator.
Natrix stolata.
Opisthotropis maxwelli.
Opisthotropis latouchii.
Ptyas korros.
Eurypholus major.
Zaocys dhumnades montanus.
Holarchus formosanus.
Holarchus violaceus.
Enhydris chinensis.
Enhydris plumbea.
Trimeresurus albolabris.
Trimeresurus mucrosquamatus.
Bungarus multicinctus.
Amblycephalus kuangtungensis.

AT ALTITUDES ABOVE 860 METERS

Hyla chinensis.
Rana japonica.
Rana latouchii.
Rana limnocharis.
Rana spinosa.
Staurois ricketti.
Microhyla butleri.
Microhyla heymonsi.
Sphenomorphus indicus.
Pseudoxenodon bambusicola.
Eurypholus major.
Natrix percarinata.
Trimeresurus mucrosquamatus.

AMPHIBIA

CAUDATA

MUTABILLIA

SALAMANDRIDÆ

1. PACHYTRITON BREVIPES (Sauvage).

Triton brevipes SAUVAGE, Bull. Soc. Philop. Paris (7) 1 (1877) 177.

Ninety-four specimens (Nos. 22416 to 22506, 24314 to 24336, M. V. Z.) were taken at Tai-yong, altitude 640 meters, eastern Kwangtung Province, August 4, 1936. The specimens were probably caught in pools connected with a small stream in the valley.

Description.—Head 3.25 times in length from snout to vent, dorsoventrally compressed, rounded anteriorly; snout subtransverse apically, projecting, canthus rostralis fairly prominent; loreal region strongly oblique; upper lip with a flap of skin extending over corner of mouth; eye small, slightly oblique, shorter than its distance from nostril, or distance between nostrils; parotoids poorly developed, terminated posteriorly by a slightly sinuous and oblique groove; dorsal surface of head smooth, flat, slightly concave, with a posteriorly pointing, slightly raised V behind middle, its apex joining vertebral line, which is slightly concave, becoming raised before base of tail. Vomerine teeth commencing in a line with anterior border of choanæ, anteriorly forming a single, fine ridge, forking slightly before middle, forming a narrow, inverted Y. Tongue with apical portion short. much narrower than mouth cavity. Limbs small, anterior pair slightly longer than, and only half as thick as, hind pair, digits slender, gradually attenuated and acute apically; fingers 3—2—4—1, and toes 3—4—2—1, in decreasing order of length; toes webbed for basal fifth. Tail nearly as long as head and body length, with moderate dorsal and ventral fins, margins parallel basally, narrowing apically to an acute tip. Cloacal lips thick and strongly swollen, longer than depth of tail, separated posteriorly, where margins are finely grooved transversely. Skin smooth, extremely fine granules or vermiculations dorsally, microporous ventrally; sides almost without wrinkles, about fourteen indistinct costal grooves discernible on upper parts; gula and throat almost without longitudinal or transverse grooves. Dark brown to blackish, with bright orange below as follows: four large irregular blotches on gula, an irregular, moderately broad, median longitudinal stripe on belly, on each side of which is a row of irregular blotches, some connected with the stripe; undersides of arms and legs with a spot near base and another near palm; lips of vent largely orange, black posteriorly. Tail bright red-orange on basal three-fourths of ventral fin, entire apical half becoming pale orange-brown, more orange on both fins, spotted and blotched with black.

Measurements of 25 males and 25 females, in millimeters.

Measurement.	Males.			Females.		
	Smallest.	Largest.	Average.	Smallest.	Largest.	Average.
Total length	71.0	87.0	74.30	81.0	101.0	84.40
Snout to anterior end of vent	38.0	43.0	42.00	43.0	55.0	47.80
Tail (from leg insertion)	34.0	45.0	37.60	40.0	48.0	46.60
Head breadth at mouth corner	9.0	11.0	10.30	10.5	12.8	11.40
Distance between limbs at side	21.0	26.0	22.30	24.0	29.0	26.80
Interocular distance	3.6	4.0	4.40	4.0	5.5	4.48
Nostril to eye	3.0	3.4	3.19	3.0	3.5	3.20
Forelimb length	15.0	16.0	15.40	15.0	17.0	16.20
Hind limb length	14.0	15.0	15.00	16.0	16.5	15.88
Tail depth at base	6.0	7.0	7.00	6.0	8.0	6.80
Length of cloacal lips	6.5	7.0	7.00	5.0	4.5	5.30

Stomach contents.—Stomachs of 25 specimens contained the following: 5 earthworms, 4 amphipod crustaceans, 3 mites, 3 lepidopterous or trichopterous larvæ, 4 other insect larvæ, 2 spiders, 2 terrestrial and 4 aquatic hemipterans, 1 small water beetle (Dytiscidæ), 1 carrion beetle (*Hister*), termites (2 stomachs), 1 centipede, 1 amphibian (?) egg, 1 reptile egg, 1 nematode parasite, 1 snail, 2 ants, and some plant material.

Distribution.—Fukien; Kiangsi; Kwangtung; Hunan; Yunnan; Tonkin.

SALIENTIA

LINGUATA

BUFONIDÆ

2. BUFO MELANOSTICTUS Schneider.

Bufo melanostictus SCHNEIDER, Hist. Amphib. 1 (1799) 216, eastern India.

Thirty-one specimens (Nos. 22525 to 22555, M. V. Z.) were taken: eastern Kwangtung Province, 19 from Tsin-leong San, altitude 850 meters, June 1 to 5; 4 from Mei-hsien city, altitude 185 meters, May 30 and 31, June 8 and 9; 1 from Kakchieh, Swatow, altitude 75 meters, May 25: southeastern Kiangsi Province, 3 from Hong San, altitude 600 to 800 meters, June 22 and July 17; 1 from Tai-au-hong, altitude 450 meters, July 6; southwestern Fukien Province, 1 from Liung-chon San, altitude 800 meters, July 25; 2 from Gang-keu, altitude 450 meters, July 22 to 26.

Description.—Head much broader than long; snout short, a vertical ridge in front, dividing between nostrils and extending along canthi rostrali and inner borders of orbits to parotids, above tympana; eyes longer than snout; tympanum vertically oval. Fingers wide, blunt, tuberculate; hind limbs with tibiotarsal articulations only reaching axillæ; heels not overlapping when hind limbs are folded at right angles to body, toes blunt, two-thirds webbed. Skin rough and closely tuberculate, largest tubercles along either side of back. Dirty brown above with tubercles mainly black; ventral surface dirty yellow mottled with blackish; tips of toes and fingers black.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum height.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
22553	female----	86	8.0	34	5.5	50	107	28	31.0	Tsin-leong.
22537	---do-----	84	6.0	29	5.0	46	96	29	29.0	Mei-hsien.
22545	---do-----	82	7.0	30	5.5	41	94	27	26.0	Tsin-leong.
22528	---do-----	78	7.0	26	5.5	41	88	25	27.0	Hong San.
22555	----------	71	7.0	28	5.0	41	89	26	27.0	Swatow.
22530	male-----	69	7.0	28	4.7	40	83	25	27.0	Gang-keu.
22529	---do-----	62	6.8	26	4.2	38	79	24	25.5	Liung-chon.
22547	---do-----	47	5.0	18	3.5	28	55	16	16.0	Tsin-leong.

Stomach contents (contents of 22 stomachs are listed separately; number in parentheses refers to number of individuals found).—Vegetable material, weevils (6), lampyrid larva, ants, caterpillar, Hemiptera, miscellaneous beetles. Mollusc, ant. Termites (125), tettigoniid. Ants (8), myriapods (6), longicorn beetles (*Philus pallescens*). Cockroaches. Ants, weevils, other beetles. Centipede, tenebrionid beetle. Ants, beetle, larvæ. Ants, scarab beetles (*Onthophagus*) (3), elaterid, tenebrionid. Ants, weevil. Ants, scarab, cicindelid, mutillid, cercopid. Weevils (6), scarab (*Anomala*), lampyrid larva, miscellaneous beetles, ants, hemipterans, caterpillar. Ants, beetles, cockroaches, rice grain, coniferous needle. Cricket, cockroach, vegetable material. Tenebrionids (3), grass. Ants, isopods (2), lampyrid larva, telephorid (?) larva. Bees (2), shrimps, isopod, scarab, weevil. Ants, myriapods, scarab, carabid. Myriapod. Weevil, longicorn and another beetle, ants, myriapod. Honey bees (2).

Distribution.—Chekiang; Fukien; Kiangsi; Kwangtung; Yunnan; Hongkong; Hainan Island; India; Ceylon; Peninsula of southeastern Asia; Sunda Islands; Philippines.

Local Hakka name.—*Sham-chu-*(*lo*).

English name.—Indian toad.

HYLIDÆ

3. HYLA CHINENSIS Guenther.

Hyla arborea var. *chinensis* GUENTHER, Cat. Batr. Sal. Brit. Mus. (1858) 108, pl. 9, fig. C.

Fifty-five specimens (Nos. 22589 to 22612, 22617 to 22647, M. V. Z.) were collected; eastern Kwangtung Province, 9 at Yim-na San, altitude 600 meters, June 12 to 16; 2 at Tai-yong, altitude 650 meters, August 5: southeastern Kiangsi Province, 15 at Hong San, altitude 650 to 1,000 meters, June 25 to 30; 1 at Tai-au-hong, altitude 550 meters, July 5; 8 at Wong-sa-shue, altitude 600 meters, July 9 to 11: southwestern Fukien Province, 7 at Liung-chon San, altitude 780 meters, July 20; 13 at Gang-keu, altitude 450 to 550 meters, July 22 to 28.

Description.—Tongue entire behind, upper jaw toothed. Head a little broader than long; snout short, subtruncate; nostrils much closer to tip of snout than to eyes, tympanum less than one-half as long as eye, separated from latter by a distance equal to its diameter. Fingers flattened-cylindrical, webbed basally, expanded apically into transversely oval discs fully twice as wide as penultimate segments; toes flattened, one-half webbed, their discs not quite as large as those of fingers. Skin smooth above; ventral surface with coarse, low granules. Bright grass-green above, white beneath; front and sides of snout and a black-edged band on each side from eye to neck brown; sides of body, front edges of femora, and posterior sides of femora and tibiæ white with distinct black spots or blotches.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Ants (25), miscellaneous beetles (3), larvæ (4), elaterid beetles (3), carabid beetle (1), cistellid (1), buprestid (1), weevil (1), pentatomid bug (2), culicid (1), and melyrid (1).

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.	Locality.
22589	female	40.0	3.5	12.0	1.5	19.0	53.0	13	11.5	Hong San.
22635	do	38.0	3.0	13.0	1.5	22.0	54.0	17	15.0	Gang-keu.
22626	do	36.0	3.0	12.0	1.5	21.0	55.0	17	15.0	Do.
22645	do	35.0	2.6	11.0	1.5	19.0	51.0	16	13.0	Yim-na San.
22598	do	34.0	3.0	12.0	1.7	20.0	51.0	15	13.5	Hong San.
22594	male	30.0	3.0	11.0	1.2	12.0	44.0	13	11.5	Do.
22640	do	28.0	2.8	11.0	1.2	17.0	47.0	15	12.0	Yim-na San.
22641	do	22.0	2.4	9.5	1.0	16.0	43.0	13	11.0	Do.
22609	female	19.5	1.8	7.0	0.9	11.0	29.0	9	7.0	Wong-sa-shue.
22601	juvenile	15.0	1.6	5.0	5.0	7.5	20.5	6	5.0	Hong San.

Distribution.—Shensi; Kiangsu; Chekiang; Fukien; Kiangsi; Kwangtung; Hunan; Yunnan; Szechwan; Hainan Island; Formosa.

Local Hakka name.—Yi Kwai.

English Name.—Chinese green tree frog.

RANIDÆ

4. RANA ADENOPLEURA Boulenger.

Rana adenopleura BOULENGER, Ann. Mag. Nat. Hist. (8) 4 (1909) 492, Fuhosho, Formosa.

Eight specimens (Nos. 22662 to 22669, M. V. Z.) were collected: 7 in southeastern Kiangsi Province, Hong San, altitude 700 to 850 meters, June 28 to 30, July 15 to 17: 1 in southwestern Fukien Province, Liung-chon San, altitude 700 meters, July 21, 1936.

New to Kiangsi Province.

Description.—Head longer than broad; snout broad, obtuse at tip, projecting; nostrils lateral, equidistant from eye and tip of snout; canthus rostralis fairly distinct; loreal region weakly concave; eye three-fourths as long as its distance from tip of snout; tympanum round, its diameter 0.75 length of eye. Vomerine teeth short, suboblique, between internal nares. Forelimbs moderately slender; fingers slender, hardly webbed, flattened and slightly expanded distally, bearing distinct subarticular tubercles, first finger barely longer than second and shorter than fourth. Hind limbs moderately slender; tibiotarsal articulation reaching, or nearly reaching, tip of snout; toes three-fourths webbed, slightly expanded and subacute at tips, with small, but prominent subarticular tubercles; inner metatarsal tubercle distinct and narrow, outer metatarsal tubercle feeble and rounded.

Skin finely tuberculate on dorsal surface of body and hind limbs, smooth beneath, wrinkled and irregularly tuberculate at sides below the moderately distinct dorsolateral folds. Males with a large triangular swollen area on each side behind forelimb. Dull brown above, with a midlongitudinal pale stripe of varying width; upper lip white above; ventral surface white, or partly speckled with brown; chin brownish in male; hind limbs banded with black.

Measurements in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
22665	female----	50	6.0	16.0	4.0	27	92	27	28.0	Hong San.
22668	male-----	47	5.5	15.0	4.4	22	72	21	21.5	Do.
22667	female----	46	5.5	15.0	3.3	23	76	23	23.5	Do.
22664	---do-----	43	6.0	14.0	3.5	26	80	24	25.0	Do.
22666	---do-----	43	5.2	13.0	3.4	23	74	22	23.0	Do.
22662	male-----	41	6.0	14.5	3.0	22	73	21	24.0	Do.
22669	---do-----	41	6.0	15.0	3.0	25	72	22	23.0	Liung-chon.
22663	---do-----	31	4.0	11.0	2.5	17	57	16	17.5	Hong San.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Ants (6), caterpillars (2), pentatomids (2), other hemipterans (1), gryllotalpid (1), elaterid (1), chrysomelid larva (1).

Distribution.—Fukien; Kiangsi; Formosa.

5. RANA FUKIENSIS Pope.

Rana fukiensis POPE, Amer. Mus. Novitat. 352 (1929) 4, pl. 4, Futsing-hsien, Fukien.

Five specimens (Nos. 22681 to 22685, M. V. Z.) were collected in southeastern Kiangsi Province, Hong San, altitude 650 meters, June 22 and 23, 1936.

New to Kiangsi Province.

Description.—Head a little longer than broad, snout wide, bluntly rounded apically, nostrils slightly closer to tip of snout than to eye, canthus rostralis rounded, not very distinct, eye slightly longer than its distance from nostril; tympanum large, round, nearly as large as eye. Forelimbs fairly short and stout; fingers feebly swollen at tips, webbed only at extreme bases, first finger longer than second, subequal to fourth; subarticular tubercles moderately distinct; hind limbs large, tibiotarsal articulation reaching a little beyond eye; toes almost completely webbed, feebly swollen at tips, subarticular tubercles small; inner metatarsal tubercles prominent, laterally compressed. Skin fairly smooth, slightly wrinkled at sides, below the distinct dorsolateral fold; vent region weakly tuberculate. Putty-gray to brown above, white below; thighs brown above and behind, spotted with white.

Measurements in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.
22685	female	78	11	26	6.0	38	123	34	41
22684	do	53	8	19	4.5	23	86	24	28
22682	male	48	7	17	3.7	25	78	21	26
22681	female	45	7	16	4.0	23	76	20	25
22683	do	44	7	15	3.5	22	70	19	23

Stomach contents.—Elaterid, 3 curculionids, melolonthid and *Serica*-like beetles; acridiid; tettigid; damsel fly; dragonfly nymph; belostomatid nymph; myriapod; spider.

Ovaries.—No. 22685 contained eggs a little less than one millimeter in diameter.

Distribution.—Fukien; Kiangsi; Formosa.

6. RANA GUENTHERI Boulenger.

Rana guentheri BOULENGER, Cat. Batr. Sal. Brit. Mus. (1882) 48, pl. 4, Amoy.

Seventy-three specimens (Nos. 22688 to 22699, 22702, 22704 to 22757, 22759 to 22762, 23115, 23116, M. V. Z.) were collected: eastern Kwangtung Province, 2 at Mei-hsien city, altitude 200 meters, May 30 and June 18; 3 at Tai-yong, altitude 650 meters, August 5 and 6: southeastern Kiangsi Province, 36 at Hong San, 650 to 840 meters, June 21 to 29, July 14 to 17; 3 at Tai-an-hong, July 4 to 6; 1 at Sungwu, altitude 500 meters, July 13; 3 at Wong-sa-shue, July 9 to 11; southwestern Fukien Province, 24 at Gang-keu, altitude 420 meters, July 22 to 28; 1 at Liungchon San, altitude 780 meters, July 22.

Description.—Head longer than broad; snout a little broader than long, rounded apically; nostrils closer to tip of snout than to eyes; canthus rostralis prominent; orbit three-fourths as long as snout; tympanum three-fourths as long as eye, finger narrow, blunt apically, first finger about as long as third; tibiotarsal articulation reaching to between eye and tip of snout; toes about three-fourths webbed, very slightly expanded apically. Skin smooth; dorsolateral fold distinct. Brown above, blackish brown at sides; tympana and sides of body reddish brown; upper lip palish, lower lip spotted with black; arms pinkish brown, spotted and vermiculated with blackish brown on femora, banded on tibiæ and feet.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
22735	female	86	11.5	25.0	5.8	46	129	39	38.0	Gang-keu.
23115	male	76	11.0	24.0	6.0	36	115	35	35.0	Hong San.
22760	female	71	12.0	22.0	5.0	40	124	37	37.0	Tai-yong.
23116	male	68	11.0	23.0	5.0	36	110	33	33.0	Hong San.
22730	female	65	9.0	22.0	5.0	38	114	34	33.0	Wong-sa-shue.
22729	do	54	8.0	18.0	4.0	32	99	29	31.0	Do.
22731	do	41	6.0	13.5	3.0	25	81	25	24.5	Tai-au-hong.
22726	do	28	4.5	8.0	2.0	15	43	14	13.0	Wong-sa-shue.
22750	juvenile	19	3.0	5.5	1.5	9	28	8	8.0	Gang-keu.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Gryllids (4); rhaphidophorid (1); tettigoniids (2); acridiids (4); tettigids (2); gryllotalpids (2), caterpillars (4); larvæ, pupæ, and adults of calliphorids (1); elaterids (2); melolonthid (1); other scarabæids (3); tenebrionid (1); histerid (1); other beetle (1); tipulid (1); odonatan (1); neuropteroid larva (1); other larva (1); centipede (1).

Distribution.—Chekiang; Fukien; Kiangsi, Kwangtung; Kwangsi; Szechwan; Kiangsu; Yunnan; Hongkong; Hainan Island; Formosa; Tonkin; Annam.

7. RANA JAPONICA (Schlegel).

Rana temporaria var. *japonica* SCHLEGEL, Fauna Japonica rept. (1838) 109, 193, pl. 3, fig. 2, Japan.

Fourteen specimens (Nos. 22758, 22773 to 22785, M. V. Z.) are in the collection: southeastern Kiangsi Province, 6 from Hong San, altitude 800 to 980 meters, June 27 to 30; 1 from Wong-sa-shue, altitude 800 meters, July 10: southwestern Fukien Province, 1 from Liung-chon San, altitude 800 meters, July 22; 4 from Gang-keu, altitude 850 meters, July 23 and 24: eastern Kwangtung Province, 1 from Tsin-leong San, altitude 850 meters, June 7, 1936.

Description.—Long and narrow; head longer than broad; snout a little broader than long, rounded; nostrils a little closer to tip of snout than to eyes; eyes nearly as long as snout; tympanum round, 0.6 as long as eye. Limbs slender; fingers feebly swollen apically, third finger much longer than fourth; toes slender, about three-fifths webbed, tips barely swollen; subarticular tubercles small but distinct; inner metatarsal tubercles short and prominent. Skin smooth; a narrow, but distinct, dorsolateral fold on body. Grayish to reddish brown, with irregular spots or streaks of darker on back; sides of snout and a wide oblique band across side of head behind eye and covering tympanum, dark brown; lips and sides of body finely spotted or mottled with dark brown; limbs banded with many brown bands; ventral surface pale and partly speckled.

Measurements of selected specimens, in millimeters.

M. C. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.	Locality.
22784	female----	52	7.0	14	3.5	28	102	31	31	Gang-keu.
22778	---do-----	50	6.0	14	3.0	28	101	31	30	Hong San.
22783	---do-----	49	6.5	14	2.8	27	92	29	28	Gang-keu.
22777	---do-----	47	7.0	15	3.0	31	102	31	31	Hong San.
22779	male-----	45	6.0	13	2.5	26	91	28	27	Do.
22785	---do-----	39	6.0	12	2.5	23	81	24	23	Gang-keu.
22773	---do-----	37	5.5	10	2.0	22	69	21	21	Hong San.
22775	---do-----	25	3.5	7	1.4	14	44	14	12	Do.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Gryllid; tettigid; orthopteran nymph; cicindelid; cistellid; elaterid; larvæ (2); ants (2); centipede.

Distribution.—Japan; Formosa; Hupeh; Hunan; Anhwei; Kiangsu; Kiangsi; Fukien; Kwangtung; Yunnan; Szechwan.

Possibly this form should be called *Rana japonica longicrus*, but the specimens are very close to those from Japan, and material from central China has been considered identical with Japanese material.

8. RANA KUHLII Dumeril and Bibron.

Rana kuhlii DUMERIL and BIBRON, Erp. Gen. 8 (1841) 384, Java.

A single male specimen (No. 22786, M. V. Z.) was taken in southeastern Kiangsi Province, at Tai-au-hong, altitude 550 meters, July 6, 1936.

New to Kiangsi Province.

Description.—Head fully as broad as long; snout broad, bluntly rounded; nostrils equidistant from eyes and tip of snout; canthus rostralis obtuse; eye three-fourths as long as its distance from tip of snout; tympanum not distinct externally. Forelimbs short, stout; first finger slightly shorter than second, both much shorter than third, subarticular tubercles fairly distinct, tips of fingers rounded; hind limbs with tibiotarsal articulations reaching eye; toes slender, three-fourths webbed, with very small discs at tips; outer metatarsal tubercle indistinct; subarticular tubercles small. Skin smooth, a few wrinkles at sides and some insignificant tubercles near vent. Dark putty-gray above, marked with brownish black as follows: four bands radiating from eye to snout, lips and tympanal region, a broad band between eyes, some irregular streaks and spots along sides and transverse bands across limbs; ventral surfaces white, slightly grayish on throat, lower lips spotted with blackish brown.

Measurements, in millimeters.—Snout to vent, 46; length of snout, 6; width of head, 19; forelimb, 22.5; hind limb, 65; tibia, 20; fourth toe, 22.

Distribution.—South China, Fukien, Kiangsi, Kwangtung; Hainan Island; Ryu-kiu (Loochoo) Islands; Formosa; Siam; Malay Peninsula; Sunda Islands; Celebes.

9. RANA LATOUCHII Boulenger.

Rana latouchii BOULENGER, Proc. Zool. Soc. London (1899) 167, pl. 19, fig. 1, Kuatun, Fukien.

Two specimens (Nos. 22787 to 22788, M. V. Z.) were collected in southeastern Kiangsi Province, Hong San, altitude 750 to 1,000 meters, June 30, 1936, along trails in damp forest.

New to Kiangsi Province.

Description.—Head a little longer than broad; snout bluntly rounded; nostrils slightly closer to tip of snout than to eyes; canthus rostralis moderately prominent; eyes slightly shorter than snout; tympanum two-thirds as long as eye. Forelimbs fairly long and slender; fingers slender, slightly expanded at tips, bearing prominent subarticular tubercles; hind limbs slender, tibiotarsal articulation reaching tip of snout, toes slender, two-thirds webbed, slightly expanded at tips; subarticular tubercles and outer metatarsal tubercles small but distinct. Skin densely granulate above, except on frontal region, fairly smooth beneath; dorsolateral fold distinct. Color mottled dark brown and pale gray, pinkish along dorsolateral fold, legs banded with black and tan; ventral surface pale, mottled with dark; lips white, mottled with dark brown.

Measurements in millimeters [*adult male and juvenile male (?), respectively*].—Snout to vent, 33, 18; length of snout, 4.5, 2.5; width of head, 11.5, 5.5; length of orbit, 4, 2; diameter of tympanum, 2.3, 1; length of forelimb, 20.5, 8.5; hind limb, 57, 25.5; tibia, 18, 8; fourth toe, 17, 7.

Stomach contents.—Otyorhynchid weevil; proctotrypid (?) wasp; chrysomelid beetle; acridiid nymph.

Distribution.—Fukien; Kiangsi, Formosa.

10. RANA LIMNOCHARIS Gravenhorst.

Rana limnocharis GRAVENHORST, Polic. Mus. Zool. Vratislav 1 (1829) 42.

One hundred thirty-four specimens (Nos. 22892 to 23025, M. V. Z.) represent this species: eastern Kwangtung Province, 57 from Tsin-leong San, altitude 830 meters, June 2 and 3; 13 from Yim-na San, altitude 550 meters, June 11 to 16; 11 at Mei-hsien city, altitude 180 meters, May 30 and 31, June 9; 2 at Tai-yong, altitude 650 meters, August 3 to 5: southeastern Kiangsi Province, 43 at Hong San, altitude 650 to 900 meters, June 21 to 29, July 15 and 16; 4 at Tai-au-hong, altitude 550 meters, July 4 to 7; 1 at Wong-sa-shue, altitude 540 meters, July 9: southwestern Fukien Province, 2 at Liung-chon San, altitude 750 meters, July 22; 1 at Gang-keu, altitude 425 meters, July 24, 1936.

Description.—Body short; head nearly as broad as long; snout bluntly rounded; nostrils almost equidistant from eyes and tip of snout; lores oblique; orbits a little shorter than snout; tympanum one-half as long as orbit. Limbs short; fingers tapering, blunt apically; tibiotarsal articulations of hind limbs reaching tympanum or eye; toes about one-half webbed, tapering, nearly pointed apically. Skin smooth beneath; back with irregular rows of short, longitudinal ridges. Color variable, generally gray or brown above with irregular black spots or bars, and a light vertebral line from tip of snout to vent; lips pale, spotted with black; ventral surface white, sides of throat black in male.

Measurements of selected specimens from Tsin-leong San, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.
23022	female	45	5.0	14	1.5	20	58	17	18
22986	do	39	5.5	13	1.8	18	57	16	18
22988	do	36	5.5	13	1.8	17	56	16	18
22987	male	33	5.0	11	2.0	18	46	13	15
22982	do	29	4.5	11	1.5	15	44	12	14

Stomach contents (number in parentheses refers to number of stomachs contained in).—Gryllids (1); caterpillars (3); ants (2); spiders (1); lepidopterous pupa (1); moth (1).

Distribution.—Shantung; Hupeh; Anhwei; Kiangsu; Kiangsi; Fukien; Kwangtung; Kwangsi; Hunan; Yunnan; Szechwan; Hongkong; Hainan Island; Formosa; Ryu-kyu (Loochoo) Islands; Peninsula of southeastern Asia; Sunda Islands; Philippines; India.

Local Hakka name.—*Si Kwai.*

English name.—Paddy frog.

11. RANA LIVIDA (Blyth).

Polypedates lividus BLYTH, Journ. As. Soc. Beng. 24 (1855) 718, Darjeeling.

Ten female specimens (Nos. 23026 to 23035, M. V. Z.) were taken in southwestern Fukien Province, Gang-keu, south of Shanghang, altitude 600 meters, July 24, 1936, from a small cascading stream in a forested canyon.

New to Fukien Province.

Description.—Head longer than broad; snout rounded; nostrils more widely separated than orbits, slightly closer to tip of snout than to eyes; lores concave; eyes about three-fourths as long as snout; diameter of tympanum barely as great as one-half length of eye. Forelimbs moderately stout; fingers feebly margined laterally, bearing large, subacute, laterally grooved discs at tips and large subarticular tubercles below; hind limbs with tibiotarsal articulations reaching or slightly exceeding tip of snout; toes webbed to discs, the latter similar to those of fingers, subarticular tubercles prominent; outer metatarsal tubercle lacking. Skin fairly smooth, slightly wrinkled above, at side, and on backs of thighs. Grass-green, with a few small brown spots on back between dorsolateral folds; sides and limbs brown, latter banded with darker; ventral surface white.

Measurements of 10 females, in millimeters.

M. V. Z. No.	Total length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.
23027	103	14.0	33	5.5	62	183	61	51
23026	102	14.0	32	5.0	61	192	62	53
23032	101	14.0	33	5.0	55	181	62	51
23033	100	14.0	31	6.0	61	186	62	52
23035	99	14.0	32	5.0	62	185	60	53
23034	97	13.0	29	5.0	60	170	55	49
23031	97	13.0	31	5.0	56	176	57	50
23030	97	13.5	31	5.0	56	178	58	51
23028	96	13.0	31	5.5	59	179	59	50
23029	96	13.5	32	5.5	62	187	60	53

Stomach contents.—Plecopteran; pentatomid bug; *Cicada*; spider.

Distribution.—Eastern Himalayas; Assam; Tenasserim; Perak; Hongkong; Kwangtung; Fukien.

12. RANA NIGROMACULATA REINHARDTII (Peters).

Hoplobatrachus Reinhardtii PETERS, Monatsber. Kön. Preuss. Akad. Wiss. Berlin (1867) 711, Malacca or China.

Twenty-one specimens (Nos. 22687, 22700, 22701, 22703, 23037 to 23053, M. V. Z.) were taken in southeastern Kiangsi Province, Hong San, altitude 650 to 850 meters, June 21 to 24, July 15, 1936.

Description.—Head longer than broad; snout subacutely rounded; nostrils slightly closer to eyes than to tip of snout; canthus rostralis obtuse; interorbital distance less than distance between nostrils; tympanum two-thirds as long as eye. Fingers attenuated apically, subarticular tubercles moderately distinct; hind limbs with tibiotarsal articulations reaching to nostrils; toes almost completely webbed, their tips slender and rounded, subarticular tubercles small but distinct; inner metatarsal tubercle minute, outer metatarsal tubercle sharp and prominent. Skin wrinkled above, smooth below, dorsolateral folds distinctly raised. Males with external vocal sacs on sides of throat. Grayish brown spotted with black above, white beneath; hind limbs banded with dark brown and white anteriorly and posteriorly.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.
23046	female	81	12	27	6.0	44	133	40	44
23047	do	77	11	27	5.5	40	120	37	41
23044	male	70	11	27	5.5	33	116	33	39
23042	do	59	10	17	4.5	29	91	27	30
23049	do	57	9	20	4.0	30	95	25	31
23037	do	39	6	14	3.5	19	57	16	19
23039	do	34	5	11	2.2	16	51	14	16
23038	juvenile	26	4	9	2.0	14	41	11	14

Stomach contents (number in parentheses refers to number of stomachs contained in).—Ants (3); spiders (3); gryllids (3); acridiids (2); gryllotalpids (2); cockroach (*Blatella*) (1); cercopid (*Cosmocarta*) (1); vespid (*Polistes*) (1); scarabæids; melolonthids (4), sericines (2); *Anomala* (1); elaterid (1); chrysomelid (1); hymenopteran (1); dipteran and neuropteran larvæ (2); tadpole (?) (1); leaves (3).

Distribution.—Chekiang; Kiangsu; Anhwei; Hunan; Fukien; Kiangsi, Kwangtung; Szechwan.

13. RANA SCHMACKERI Boettger.

Rana schmackeri BOETTGER, Kat. Batr. Saml. Senck. Ges. (1892) 11, Ichang, Hupeh.

Ten specimens (Nos. 22671 to 22680, M. V. Z.) were taken: southwestern Fukien Province, 7 from Gang-keu, altitude 600 meters, July 24; southeastern Kiangsi Province, 3 from Hong San, altitude 700 meters, June 24 and July 16, 1936, in cascades of mountain streams.

New to Kiangsi Province.

Description.—Head slightly broader than long; snout broad and bluntly rounded; nostrils about equidistant from eyes and tip of snout; canthus rostralis short, rounded; eyes about as long as snout; tympanum nearly one-half as long as eye. Fingers long, feebly margined laterally, expanded apically into discs nearly twice as broad as penultimate segments; tibiotarsal articulation reaching to between eyes and tip of snout, or beyond latter, toes almost completely webbed, apical discs barely larger than those of fingers. Skin with low, coarse granules above, subtuberculate at sides and smooth beneath. Green above with many brown spots of varying size; ventral surface white except for four dark areas on each side of lower lip.

Measurements of 10 females, in millimeters.

M. V. Z. No.	Total length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.
22617	92	10.0	29	4.5	47	151	46	45
22675	87	10.6	29	4.5	52	161	47	48
22680	85	11.0	31	4.5	50	157	47	45
22672	85	12.0	31	4.5	49	153	50	45
22676	83	10.0	27	4.5	48	143	45	43
22673	82	11.0	31	5.0	46	155	47	43
22674	81	9.0	29	4.6	49	152	48	43
22678	81	10.0	28	4.0	50	155	48	43
22671	79	10.0	28	4.8	50	151	48	44
22679	69	9.5	25	4.2	39	137	42	40

Stomach contents (number in parentheses refers to number of stomachs contained in).—Beetles, cerambycids (*Astathes, Pterolophia, Dihammus?*) (3); melolonthid; scarabæid; chrysomelid (*Oides*); arboreal cicindelid; cistellid; beetle larva; *Cicada;* dragonfly; dipteran; spider; indeterminate arthropods.

Distribution.—Hupeh; Kiangsi; Fukien; Kwangtung; Hainan Island; Tonkin.

14. RANA TIGERINA RUGULOSA Wiegmann.

Rana rugulosa WIEGMANN, Nova Acta Leop.-Carol. 17 (1) (1835) 258, Cape Syngmore, China.

Sixteen specimens (Nos. 23059 to 23074, M. V. Z.) were taken: eastern Kwangtung Province, 14 from Tai-yong, altitude 640 meters, August 3 to 5: southwestern Fukien Province, 2 from Gang-keu, altitude 400 meters, July 23 to 26, 1936.

Description.—Heavy-bodied; head broad, oblique at sides and front; snout blunt; nostrils one-half way between tip of snout and eyes; tympanum diameter 0.75 of orbit. Arms stout; fingers and toes tapering, blunt, the latter completely webbed. Skin with longitudinal ridges of varying length, and tubercles, on back and legs. Dark brown, mottled or splotched with black; legs indistinctly banded; throat white with dark spots.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.
23061	female	107	16	44	8.0	56	165	46	52
23062	male	95	13	33	6.5	46	135	32	42
23071	female	76	10	29	5.5	36	112	31	35
23063	do	72	11	25	4.0	35	97	28	31
23060	do	62	10	24	4.5	29	87	25	28
23069	do	33	5	12	2.0	16	43	12	12

Stomach contents (number in parentheses refers to number of stomachs contained in).—5 *Rana limnocharis* (4); *Microhyla ornata* (1); weevils (2); melolonthid (1); *Onthophagus* (1); cicindelid (*Collyris*) (1); 3 carabids (2); elaterid (1); gryllid (2); tettigoniid (1); acridiid (1); gerrid (1); *Sphæroderma* (1) ichneumonid (1); larva (1); spider (1); myriapod (1); earthworm (1).

Distribution.—Anhwei; Kiangsu; Chekiang; Kiangsi; Fukien; Kwangtung; Hunan; Yunnan; Szechwan; Hainan Island; Hongkong; Formosa; Japan.

15. RANA SPINOSA David.

Rana spinosa DAVID, Journ. Trois Voy. Chinois 2 (1875) 253, northern Kiangsi.

Sixteen specimens (Nos. 23075 to 23089, 25322, M. V. Z.) were taken: southern Kiangsi Province, 8 from Hong San, altitude 750 meters, June 21 to 23; southwestern Fukien Province, 3 from Haba, altitude 500 meters, July 17; 3 from Gang-keu, altitude 600 meters, August 6, 1934.

Description (breeding male).—Broad; head as broad as shoulders, broader than long; snout more than twice as broad as long, blunt; nostrils more widely separated than orbits, closer to latter than to tip of snout; eyes nearly as long as their distance from tip of snout; tympanum indistinct; a fold from corner of eye to front of shoulder. Forelimb stout, nearly as thick as thigh; fingers tapering, bluntly rounded apically, first finger longer than second, bent, strongly swollen in middle and with a large swelling at base, latter and outer sides of first three fingers armed with acute, black, spiny tubercles. Toes completely webbed, apically swollen into subspherical discs, subarticular tubercles strongly swollen, inner metatarsal tubercle long and narrow, prominent, outer metatarsal tubercle lacking. Skin thick, wrinkled and irregularly tuberculate on back, in part with short ridges; chest with many large, briefly spined tubercles. Blackish brown above, yellowish white beneath with dark mottlings on lower lip, throat, and undersides of legs, tubercles on chest and fingers black-tipped. *Female.*—Forelimbs not greatly swollen; fingers and chest nontuberculate. No. 23080 contained eggs 3 to 4 millimeters in diameter (June 23).

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23078	male	127	12.0	50	54	180	55	53	Hong San.
23085	do	122	13.0	50	60	182	55	52	Haba.
23079	do	114	11.5	50	53	181	54	52	Hong San.
23083	female	105	11.0	40	47	147	44	45	Gang-keu.
23077	male	95	11.0	37	44	156	45	42	Hong San.
23089	do	69	8.5	28	31	112	33	34	Tai-yong.
23088	female	65	8.0	27	34	114	32	34	Do.

Stomach contents (number in parentheses refers to number of stomachs contained in).—5 scarabæids (3); carabid (1); prionid (1); other beetles (2); blattid (1); tettigoniid (1); acridiid (1); gryllid (1); 2 rhaphidophorids (1); ants (3); myriapod (1); pentatomid (1); 2 crabs (1); indeterminable insects (2); vegetable material (3).

Distribution.—Hupeh; Chekiang; Kiangsi; Fukien; Kwangtung; Hongkong; Yunnan; Szechwan; Tonkin.

Local Hakka name.—*Shak-lun* (rock dragon).

English name.—Chinese edible frog.

16. RANA TAIPEHENSIS Van Denburgh.

Rana taipehensis VAN DENBURGH, Proc. Cal. Acad. Sci. (4) 3 (1909) 56, Taipeh, Formosa.

A single male specimen (No. 23103, M. V. Z.) was taken in southwestern Fukien Province, Gang-keu, altitude 420 meters, July 23, 1936.

Description.—Slender; head one and one-half as long as broad; snout nearly as long as broad, narrowly rounded apically, projecting; nostrils lateral, closer to tip of snout than to eyes; eyes two-thirds as long as snout; tympanum distinct and subtransparent, as long as eye. Limbs slender; fingers expanded apically into discs a little less than twice as wide as penultimate phalanges; hind limbs with tibiotarsal articulations reaching to nostrils; toes slightly more than one-half webbed, expanded apically into discs a little smaller than those of fingers. Skin fairly smooth. Light gray on upper part of body, more brownish at sides, with fine, narrow, longitudinal, silvery-white stripes, one median, one on each side along canthus rostralis, upper eyelid and dorsolateral fold, and another on each side along lower lip and lower side of body; legs tan above, feebly banded; ventral surfaces white.

Measurements.—Snout to vent, 21 mm; length of snout, 4; width of head, 8; diameter of tympanum, 3; length of arm, 14; leg, 44; tibia, 13; fourth toe, 14.

Stomach contents.—One spider.

Distribution.—Formosa; Hongkong; Hainan Island; Kwangtung; Fukien.

17. STAUROIS RICKETTI (Boulenger).

Rana ricketti BOULENGER, Proc. Zool. Soc. London (1899) 168, pl. 19, fig. 2, Kuatun, Fukien.

Fifteen specimens (Nos. 23117 to 23131, M. V. Z.) were collected in southeastern Kiangsi Province, Hong San, altitude 800 to 875 meters, July 15 to 17, 1936, among or on boulders in a small precipitous mountain stream.

New to Kiangsi Province.

Description.—Vomerine teeth strongly oblique, nearly uniting posteriorly. Body dorsoventrally compressed; head broader than long; snout short, broadly rounded, tip projecting beyond upper lip; nostrils equidistant from tip of snout and eyes; orbit longer than snout; tympanum barely one third diameter of orbit. Fingers narrow, apices expanded into discs nearly three times as wide as penultimate phalanges; hind limbs with tibiotarsal articulations reaching eye or nostril; toes five-sixths webbed; apical discs not quite as large as those of fingers. Skin finely and sparsely granulose above, smooth beneath. Black or blackish brown above, mottled with pale; ventral surface white, more or less mottled with dark on throat.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.
23130	female	67	7.0	21	2.2	33	91	28	27
23126	do.	53	6.0	17	2.0	30	85	25	25
23117	do.	51	6.0	19	2.0	33	90	28	24
23125	do.	48	4.5	18	1.5	28	75	23	21
23131	do.	47	5.5	16	1.7	27	73	23	21
23130		38	4.5	13	1.0	22	65	20	18

Stomach contents.—2 dascyllid beetles; 2 centipedes; myriapods; weevil; hemipteran; forficulid; heteroceran; tipulid; icheumonid; larva, spider; *Rana limnocharis* (?).

Distribution.—Fukien; Kiangsi; Kwangtung; Tonkin.

18. ŒIDOZYGA LIMA (Gravenhorst).

Rana lima GRAVENHORST, Delic. Mus. Zool. Vratislav 1 (1829) 41, Java.

Three specimens (Nos. 22659 to 22661, M. V. Z.) were collected in rice fields in southwestern Fukien Province, at Gang-keu, south of Shanghang, altitude 400 meters, July 26 to 28, 1936.

Description.—Head broader than long; snout short and blunt; nostrils dorsal, slightly closer to eyes than to tip of snout; interorbital space very narrow; eyes nearly as long as snout; tympanum hidden. Forelimbs short; fingers slender and pointed, their subarticular tubercles small; hind limbs large, tibiotarsal articulations reaching eye; toes slender, subacute, completely webbed, their tubercles on ventral surface larger and less acutely raised. Dusky white, with a dark streak on either side of throat; posterior face of thigh with a black stripe above and below with white.

Measurements in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head length.	Forelimb.	Hind limb.	Tibia.	Fourth toe.
22660	male	18.0	2.0	7.0	9.0	27	7.5	9.0
22661	do.	17.0	2.0	6.5	9.0	26	7.0	9.5
22659		15.5	1.6	6.0	7.5	24	6.0	8.0

Stomach contents.—One spider; one collembolan (?).

Distribution.—Sunda Islands; peninsula of southeastern Asia; Hainan Island; Hongkong; Fukien; Kwangtung.

19. RHACOPHORUS DENNYSI (Blandford).

Rhacophorus dennysi (BLANDFORD), Proc. Zool. Soc. London (1881) 224, pl. 21, Singapore specimen brought from China.

Four specimens (Nos. 23134 to 23137, M. V. Z.) were collected: southeastern Kiangsi Province, 2 at Tai-au-hong, south of Sungwu, altitude 550 meters, July 6 and 7; 1 at Hong San, northeast of Sungwu, altitude 840 meters, July 15: southwestern Fukien Province, 1 at Kwa-tze-piang, between Haba and Wuping, altitude 560 meters, July 18, 1936.

Description.—Head large, broader than long; snout broad, obtusely rounded; nostrils a little closer to end of snout than to eyes; eyes two-thirds as long as snout; tympanum three-fifths as long as eye, forelimbs large; fingers broad, one-third to three-fourths webbed, expanded into large discs wider than tympanum at tips, subarticular tubercles large; toes expanded, completely webbed, apical discs about two-thirds as wide as those of fingers. Skin smooth or feebly tuberculate above, reticulate-granulose beneath. Bright green above with a few asymmetrically placed, rounded, brown splotches of varying size on top of head and anterior portion of back; sides of body with irregular spots; limbs with external stripes of silvery white, distinctly edged with green, brown, or black; ventral surfaces whitish.

Measurements in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Tympanum diameter.	Forelimb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23134	female	115	13	6.0	67	165	51	46	Tai-au-hong.
21137	do	90	12	6.0	63	147	43	44	Kwa-tze-piang.
23135	do	80	9	5.0	51	125	40	35	Tai-au-hong.
23136	juvenile	31	3	1.3	17	44	14	12	Hong San.

Stomach contents (number in parentheses refers to number of stomachs).—Caterpillars (2); cicada (*Platypleura*); phasmid; weevil; arboreal tenebrionid; isopod (?); bird feather.

Distribution.—Fukien; Kiangsi; Kwangtung; Kwangsi.

Local Hakka name.—*Chang Kwai.*

20. RHACOPHORUS LEUCOMYSTAX (Gravenhorst).

Hyla leucomystax GRAVENHORST, Delic. Mus. Vratislav (1829) 26, Java.

Twenty-one specimens (Nos. 23148 to 23168, M. V. Z.) are in the collection: eastern Kwangtung Province, 1 from Tsin-leong San, altitude 850 meters, June 6; 3 from Yim-na San, altitude 500 meters, June 10 to 15, 3 from Tai-yong, altitude 650 meters, August 3: southeastern Kiangsi Province, 2 from Tai-au-hong, altitude 550 meters, July 4; 1 from Wong-sa-shue, altitude 750 meters, July 11; southeastern Fukien Province, 3 from Liungchon San, altitude 760 meters, July 21; 8 from Gang-keu, altitude 550 meters, July 23 to 28, 1936.

New to Kiangsi Province.

Description.—Head practically as broad as long; snout much broader than long, rounded apically, subacute in males; nostrils much closer to tip of snout than to eyes; eyes three-fourths as long as snout; tympanum five-eighths as long as eye in female, one-half as long in male. Fingers dorsoventrally compressed, widely expanded into apically broadest discs at tips; hind limbs long, tibiotarsal articulation reaching to between eyes and snout; toes depressed, three-fourths webbed, fringed laterally on free portions and expanded apically into discs about three-fourths as wide as those of fingers. Skin largely smooth above, with broad, flat granules on belly and under surfaces of femora, occasionally finely granulate on sides of head. Color mottled, partly gray to brown above with a figure on anterior portion of back somewhat resembling an hour glass with arms extended to upper eyelids and backwards to upper part of sides at about middle of body, and some bands across limbs, of grayish or brownish black; some white spots on back, or black spots on white background on flanks and sides of thighs; ventral surfaces dirty white mottled on throat with black.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Tympanum diameter.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.
23153	female	71	8.0	24.5	5.0	40	113.0	35	28
23151	do	68	8.0	24.0	4.5	41	112.0	34	27
23152	do	66	8.0	24.0	5.0	38	112.0	35	28
23154	do	58	7.0	21.5	4.0	33	91.0	24	23
23159	do	56	7.0	21.0	4.0	33	89.0	27	22
23157	male	52	7.5	18.5	3.5	31	83.0	26	22
23165	do	43	5.0	15.0	3.0	25	69.0	21	16
23156	do	41	6.0	15.5	3.0	24	61.0	18	16
23162	juvenile	16	2.0	6.0	1.0	8	18.5	6	5

Distribution.—Sunda Islands; Philippines; peninsula of southeastern Asia; India; Hainan Island; Formosa; Hongkong; Kwangtung; Fukien; Kiangsi; Kiangsu.

Local Hakka name.—P'ak-kwai; Chuk-k'yok-k'wai.

English name.—Brown tree frog.

MICROHYLIDÆ (BREVICIPITIDÆ)

21. KALOULA PULCHRA PULCHRA Gray.

Kaloula pulchra GRAY, Zool. Misc. (1831) 38, China.

Four specimens were collected by paths at night: M. V. Z. No. 23190, at Lingnan University, Honam Island, Canton, south-central Kwangtung Province, altitude 20 meters, May 24; M. V. Z. Nos. 23191 to 23193 at Kakchieh, across the river from Swatow, eastern Kwangtung Province, altitude 75 meters, May 25 and July 31, 1936.

The Swatow specimens represent a new, and the most eastern, record for the species.

Description.—Head very small, broader than long; snout short, rounded-truncate; nostrils closer to tip of snout than to eyes; tympanum hidden. Fingers moderately slender, with thickened joints, broad, truncate, apical phalanges, and distinct subarticular tubercles; hind limbs short, tibiotarsal articulation not reaching axilla; both metatarsal tubercles distinct, inner metatarsal tubercle more prominent; toes moderately slender, one-third webbed, barely expanded, rounded-truncate apically, with distinct, rounded, subarticular tubercles. Skin moderately smooth; granular on gular region, feebly granular on top of head and sides of body. Purplish brown with a broad pinkish stripe along each side of back from eye, and a transverse stripe across head between eyes.

Measurements in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23191	male	68	5.0	40	68	20	22	Swatow.
23192	do	63	5.0	36	59	20	22	Do.
23193	female	58	4.5	37	62	17	21	Do.
23190	do	58	4.0	32	59	17	19	Canton.

Stomach contents.—Ants; termites; spiders; larvæ; carabid beetle.

Distribution.—Kwangtung; Hongkong; peninsula of southeastern Asia; Sunda Islands; India.

Key to the species of Microhyla.

1. Tibia contained at least twice in body length; fourth toe longer than tibia; toes webbed only at extreme bases .... 2.

Tibia contained only slightly more than one and one-half times in body length; fourth toe shorter than tibia; toes webbed for at least one-third their lengths; length from snout to vent over 25 millimeters. *M. pulchra.*

2. Tibia contained about twice in body length; hind legs one and three-fourths times as long as body........ 3.
Tibia contained more than twice in body length; hind leg one and one-half times as long as body........ *M. ornata.*
3. Skin of back finely granulose; pale pinkish with sides of body contrastingly dark .... *M. heymonsi.*
Skin of back with small, slightly raised pinkish red spots and a dark, lobed pattern along middle; sides not very dark........ *M. butleri.*

22. MICROHYLA BUTLERI Boulenger.

Microhyla butleri BOULENGER, Ann. & Mag. Nat. Hist. (7) 6 (1900) 188, Larut Hills, Perak.

A single specimen (No. 23194, M. V. Z.) was taken at southeastern Kiangsi Province, Hong San, altitude 1,050 meters, June 29, 1936.

New to Kiangsi Province.

Description.—Head not distinct from neck; snout broader than long, rounded; nostrils a little closer to tip of snout than to eyes, eyes three-fifths as long as snout. Forelimbs small; fingers slender, slightly expanded apically, fourth two-thirds as long as third; hind limbs with tibiotarsal articulations nearly reaching tip of snout; toes long and slender, one-fourth to one-third webbed, barely expanded apically. Skin fairly smooth, with scattered feeble swellings on dorsal surface. Pale gray, tinged with pink, marked above with a forward-pointing trident-shaped figure extending from between eyes to above shoulders, and a large X-shaped mark on middle of back, followed by an inverted V, all blackish gray; dorsal tubercles pinkish red; hind limbs narrowly banded with dark; throat, chest, flanks, and undersides of limbs densely speckled with dark.

Measurements, in millimeters.—Length, from tip of snout to vent, 28; length of snout, 2.2; width of head, 7; length of forelimb, 13; hind limb, 39; tibia, 11; fourth toe, 12.5.

Stomach contents.—Small ants.

Distribution.—Peninsula of southeastern Asia; Hainan; Kwangtung; Kiangsi; Fukien; Szechwan.

23. MICROHYLA HEYMONSI Vogt.

Microhyla heymonsi VOGT, Sitzgsber. Natur. Fr. Berlin (1911) 181. Formosa.

Nineteen specimens (Nos. 23195 to 23213, M. V. Z.) were taken: eastern Kwangtung Province, 6 at Tsin-leong San, altitude 850 meters, June 2 to 4, 1 at Yim-na San, altitude 600 meters, June 14: southeastern Kiangsi Province, 2 at Hong San, altitude 950 meters, June 28, July 16, 5 at Tai-au-hong, altitude

540 meters, July 3 to 6: southwestern Fukien Province, 2 at Liung-chon San, altitude 800 meters, July 22, 3 at Gang-keu, altitude 550 meters, July 23 to 25.

New to Kwangtung and Kiangsi Provinces.

Description.—Head small; snout rounded; nostrils halfway between eyes and tip of snout; eyes two-thirds as long as snout. Fingers slender, slightly swollen at tips, third much longer than others; toes slender, slightly flattened, webbed only at extreme bases, subarticular tubercles and metatarsal tubercles small. Skin smooth, or with some scattered, minute granules above. Pink or pinkish gray with sides of body black or dark brown and dorsal surface with a faint pattern of irregular longitudinal stripes, a V-shaped mark between eyes, and a black spot near middle of back divided by a pale, slender, vertebral line; throat dusky; abdomen dirty white; legs distantly banded.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23211	female	23.5	2.0	6.0	12.0	40.0	12.0	12.0	Gang-keu.
23208	do	23.0	2.4	6.5	11.0	37.0	11.0	12.0	Hong San.
23203	male	21.0	2.2	7.0	11.0	37.0	11.0	11.5	Tai-au-hong.
23206	do	19.0	1.6	6.5	10.0	33.0	10.0	11.0	Do.
23195	do	17.7	1.7	5.5	8.5	29.0	9.0	10.0	Tsin-leong San.
23213		15.0	1.7	4.5	6.3	22.0	6.5	7.0	Gang-keu.
23201		8.0	1.0	3.0	4.5	12.5	3.7	4.0	Yim-na San.

Stomach contents.—Ants; termites; elaterid; coccinellid.

Distribution.—Fukien; Kiangsi; Kwangtung; Formosa.

This species was collected at night in short grass on the dykes at edges of paddy fields, where the sharp, frequently repeated chirplike call was very audible.

24. MICROHYLA ORNATA (Dumeril and Bibron).

Engystoma ornatum DUMERIL and BIBRON, Erpet. Gen. 8 (1841) 745, Malabar coast.

Thirty-two specimens (Nos. 23224 to 23255, M. V. Z.) represent this species; eastern Kwangtung Province, 13 from Tsin-leong San, altitude 550 meters, June 2 to 6; 3 from Mei-hsien city, altitude 185 meters, June 8 and 9; 3 at Tai-yong, altitude 650 meters, August 5 and 6; southeastern Kiangsi Province, 2 at Tai-au-hong, altitude 550 meters, July 4 to 7; 1 at Wong-sa-shue, altitude 575 meters, July 9; 1 at Hong San, altitude 650 meters, June 21: southwestern Fukien Province, 9 at Gang-keu, altitude 420 meters, July 25 and 26.

Description.—Nostrils separated by a distance slightly less than interorbital distance; eyes two-thirds as long as snout. Fingers blunt at tips, fourth finger two-thirds as long as third; hind limbs with tibiotarsal articulations not reaching eyes; toes blunt at tips, scarcely webbed. Skin smooth. Gray; sides grayish black, distinctly margined above, back with a pair of sinuous black stripes, starting together as a triangle on occiput, diverging posteriorly and continuing to groins, another pair forming a broad inverted V on posterior part of back indistinctly striped with gray; a faint middorsal pale line; throat black in male.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Fore-limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23226	female	23.5	2.2	6.0	11	34	10.0	11.5	Tai-au-hong.
23246	do	22.5	2.0	6.5	10	34	01.0	11.0	Tsin-leong San.
23225	male	21.0	2.0	6.0	10	33	10.0	11.0	Wong-sa-shue.
23224	do	21.0	2.0	5.5	9	31	9.0	10.0	Hong San.
23251	juvenile	9.0	1.0	3.0	6	10	3.3	4.0	Tsin-leong San.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Ants in every stomach, small beetles (2); termites (2).

Distribution.—India; Ceylon; peninsula of southeastern Asia; Hainan; Formosa; Hongkong; Kwangtung; Fukien; Kiangsi; Chekiang; Kiangsu; Anhwei; Szechwan; Hunan.

25. MICROHYLA PULCHRA (Hallowell).

Engystoma pulchrum HALLOWELL, Proc. Acad. Nat. Sci. Philad. (1860) 506, between Hongkong and Whampoa.

Nineteen specimens (Nos. 23270 to 23288, M. V. Z.) were collected: southwestern Fukien Province, 16 at Gang-keu, altitude 400 meters, July 24 to 26; eastern Kwangtung Province, 2 at Tsin-leong San, altitude 850 meters, June 2 to 4; 1 at Yim-na San, altitude 550 meters, June 14.

Description.—Snout rounded; nostrils separated by a distance greater than interorbital space; eyes four-fifths as long as snout. Fingers tapering, free part of third finger twice as long as that of fourth; hind limbs with tibiotarsal articulations extending well beyond tip of snout; toes one-third to one-half webbed, tapering, subarticular tubercles distinct. Skin smooth above and beneath. Pale whitish gray with a transverse bar across top of head, an interrupted lateral stripe and a large inverted V on back, followed by isolated subovate spots on back and legs, of black, mostly edged with pale; anterior portion of back with faint grayish stripes parallel to borders of large V; throat and chest mottled.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Body length.	Snout length.	Head width.	Fore limb.	Hind limb.	Tibia.	Fourth toe.	Locality.
23273	female	33.0	4.0	10.0	15.0	57	19.0	17.0	Gang-keu.
23288	male	30.0	3.5	9.5	14.0	56	18.0	17.5	Tsin-leong San.
23271	do	28.5	3.2	9.0	14.0	52	18.0	16.0	Do.
23270	do	27.0	3.0	8.5	14.0	53	17.0	16.0	Do.
23279	juvenile	17.0	1.7	6.0	8.5	32	11.0	9.5	Do.
23286	do	12.0	1.5	3.8	5.0	19	6.5	6.0	Yim-na San.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Ants (most stomachs); termites; weevil (1); beetle (1).

Distribution.—Kwangtung; Fukien; Hupeh; Hongkong; Hainan Island; Tonkin; Cochin-China; Siam.

REPTILIA

SQUAMATA

SAURIA

GEKKONIDÆ

26. GEKKO SUBPALMATUS Guenther.

Gekko subpalmatus GUENTHER, Rept. Brit. India (1864) 104, pl. 12, Chekiang.

Two specimens (Nos. 23343 and 23344, M. V. Z.) were collected: eastern Kwangtung Province, 1 at Tsin-leong San, altitude 850 meters, June 5: southeastern Kiangsi Province, 1 at Hong San, altitude 900 meters, on outside of house at night, June 25, 1936.

New to Kiangsi Province.

Description (23343 and 23344, respectively).—Rostral nearly twice as broad as deep, bordering nostrils; three, and four internasals, respectively, bordering rostral between nostrils; eye nearly two-thirds as long as snout; ear opening with diameter of that of eye. Supralabials 11; infralabials 9, 10; 8, 9; throat covered with minute, even granules; ventral surface of body covered with minute granules, tubercles lacking; tail covered with transverse rows of granular scales above and at sides, and with larger, flatter scales beneath. Humeri and femora with granules larger than those on dorsal surface of body; infradigital lamellæ 9, 9, 10, 12, and 9 on first to fifth fingers, respectively; lamellæ on undersides of toes 10, 12, 13, 15, and 13 on first to fifth toes, respectively. Nine and 12 femoral pores on each side, respectively; a single large tubercular scale on each side of swollen vent region at base of tail. Grayish black and pale gray above, dark, and light grayish white beneath, respectively; infralabials speckled in No. 23343; no banding distinguishable.

Measurements in millimeters.—Total lengths, 82 and 74, respectively; snout to vent, 43, 41; snout to ear opening, 10; width of head, 7, 7.5; axilla to groin, 21, 20; forelimbs, 10; hind limbs, 15, 14.

Distribution.—Szechwan; Kiangsi; Chekiang; Fukien; Kuangtung.

27. HEMIDACTYLUS BOWRINGII (Gray).

Doryura Bowringii GRAY, Cat. Liz. Brit. Mus. (1845) 156, probably Hongkong.

Two specimens (Nos. 23296 and 23297, M. V. Z.) female and male, respectively, were collected in eastern Kwangtung Province, at Mei-hsien (Kaying, Moejen), altitude 200 meters, June 8, 1936, on the outside of houses at night.

Description.—Snout nearly twice as long as eye. Rostral strongly indented above; supralabials 11; infralabials 8; mental large, acute behind; two pairs of enlarged chin shields, those of second pair distant. Dorsal surface of head and body covered with small granular scales of only slightly varying size, those on tail arranged in irregularly transverse rows. Lamellæ on undersides of fingers and toes divided; infradigitals 3, 7, 8, 9, and 6 on first to fifth fingers, respectively; toe lamellæ 5, 8, 11, 11, and 7, respectively. Male with 13 femoral pores on each side. Pale grayish white mottled with irregular faint dark markings above; white beneath.

Measurements, in millimeters (Nos. 23296 and 23297, respectively).—Total length, 94, 93; snout to vent, 44, 45; snout to ear opening, 13.5, 12; axilla to groin, 22, 21; forelimbs, 14; hind limbs, 17.

Distribution.—Fukien; Kwangtung; Hongkong; Yunnan; Burma; India; Formosa; Ryu-kyu (Loochoo) Islands.

AGAMIDÆ

28. GONOCEPHALUS LEPIDOGASTER (Cuvier).

Calotes lepidogaster CUVIER, Eg. Anim. ed. 2 2 (1829) 39, Cochin-China.

Fourteen specimens (Nos. 23419 to 23432, M. V. Z.) represent this species: No. 23432 was taken in eastern Kwangtung Province, at Yim-na San, altitude 650 meters, June 14; all the others were taken in southwestern Fukien Province, at Gangkeu, altitude 575 to 650 meters, July 23 to 26, on shrubbery in the jungles.

Description.—Head triangular in front, rectangular behind, concave between and before eyes and on loreal region; canthus rostralis and supraoculars prominent; snout rounded apically, nearly one and one-half times as long as eye cavity. Scales on top of head small, irregular, about 17 in a row between supraoculars, supraoculars 6 on either side; nostril five-eighths distance from end of snout to eye; supra- and infralabials 9 to 11, similar in size and shape; mental narrow, acute behind; chin shields very small, those of first pair meeting or separated; throat scales small, carinate, subacuminate. Tympanum visible, one-fourth diameter of eye. A strong emargination behind last supraocular, followed by a curved spine 2 or 3 millimeters long; two strong spines and some lesser spines at each side of occiput; nuchal crest composed of 6 or 7 strong, laterally compressed spines, 6 millimeters long in No. 23432 (male); dorsal crest of strongly carinate or compressed spinous scales; dorsal surface of body covered with small, irregular, smooth scales, large, acuminate scales at intervals; ventral scales and all tail scales strongly carinate. Male (No. 23432) black on upper portion of head and neck; lower parts bluish white; sides of body and legs blue-green; banded along back, and spotted on sides and legs with black; tail blackish brown, banded with blue; some males less distinctly colored; females dirty brown with traces of male pattern, lower eyelid vertically banded.

All the females contained eggs without evident embryos, generally 9 to 13 in number and measuring 4 to 9 millimeters in diameter, fairly round.

Stomach contents (*number in parentheses refers to number of stomachs contained in*).—Indeterminable insects (8); adult beetles (3); crickets (2); snail (2); centipede (1); hymenopteran wasp (?); and a scarabæid beetle larva (?).

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout to vent.	Snout to tympanum.[a]	Head width.	Arm length.[b]	Leg length.	Fourth toe.[c]
23432	male	227	80	25.0	18.5	46	70	25
23431	female	211	88	22.0	15.5	47	73	25
23419	do	202	83	22.0	14.0	43	63	23
23428	do	186	76	21.5	13.5	43	62	22
23429	male	217	77	22.0	14.5	51	72	26
23424	do	218	76	21.0	14.5	48	70	24
23425	do	188	65	18.0	13.0	42	61	22
23421	do	95	38	11.0	8.0	24	34	12

[a] This measurement includes tip of snout to posterior edge of tympanum.

[b] Width across head at supraoculars.

[c] Measured on outer side of fourth toe.

Distribution.—Fukien; Kwangtung; Kwangsi; Hainan Island; Indo-China; Siam; Burma.

Local Hakka name.—San-kyu-tai.

SCINCIDÆ

29. SPENOMORPHUS INDICUS (Gray).

Hinulia indica GRAY, Ann. & Mag. Nat. Hist. (2) 12 (1853) 388, Sikkim.

Ten specimens (Nos. 23528 to 23537, M. V. Z.) represent this species: southern Kiangsi, 7 adults from Hong San, altitude 750 to 900 meters, June 29 and July 16; southwestern Fukien Province, 1 adult and 2 juveniles from Gang-keu, altitude 600 meters, July 23 and 24, 1936.

New to Kiangsi Province.

Description.—Nasal obliquely oval, frontonasal broader than long, broadly in contact with rostal, nasals, and prefrontals, narrowly bordering frontal and anterior loreals; frontal twice as broad as long, strongly narrowed and nearly acute posteriorly; frontoparietals two-thirds as long as frontal, larger than interparietal and smaller than parietals; parietals obliquely transverse; supraoculars 5; snout a little longer than eye; supralabials 7, sometimes 8; first chin shield entire, those of second pair touching, third pair separated. Body encircled at middle with 36 to 38 longitudinal rows of scales. No. 23531 with about 87 scales in a row along midventral line from chin to vent, its longest toe with about 20 scales along underside. Brown speckled with black and tan above, white with greenish iridescence below, and dark brown speckled with pale blue on upper parts of sides, changing to pale blue speckled with dark brown on lower parts of sides; a fine dark line along upper part of sides of unregenerated tail.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout to vent.	Snout to ear.	Head width.	Axilla to groin.	Arm length.	Leg length.
23530	female	249	97	18	13.0	49	22	36
23531	do	205	96	19	13.0	50	25	39
23532	male	195	87	19	12.0	44	24	39
23537	female	204	77	16	11.0	37	23	36
23533	do	164	60	14	9.0	31	16	27
23536	juvenile	(57)	27	7	5.5	12	9	14

No. 23529 contained twelve eggs with embryos just beginning to be pigmented, 36 to 44 millimeters long.

Stomach contents (number in parentheses refers to number of stomachs contained in).—Caterpillars (3), beetles (2), crickets (6), earwig (1), termites (1), earthworm (1), snail (1).

Distribution.—Southern, central, and western China and Shensi; Himalaya and Annam to Malay Peninsula.

30. ATEUCHOSAURUS CHINENSIS Gray.

Ateuchosaurus chinensis GRAY, Cat. Liz. Brit. Mus. (1845) 107, China.

A single imperfect specimen (No. 23541, M. V. Z.) was found dead on a porch in Swatow, eastern Kwangtung Province, altitude 40 meters, August 26, 1936.

Description.—Head not distinct from neck, narrowed anteriorly; enlarged plates few; frontal more than twice as long as broad, extending nearly to posterior border of eyes, constricted in middle; frontoparietals very small; interparietals subequal in size to each frontoparietal; parietals hardly longer than frontoparietals, transverse, supraoculars 4 or 5; scales on posterior portion of head similar to those on neck, body and tail, broadly hexagonal, smooth; ten rows of scales across occiput between ear openings; scales in about 30 rows around middle of body; about 36 scales in a row from axilla to base of hind limb.

Measurements, in millimeters.—Length, from snout to vent, 64; breadth of head, 9; axilla to groin, 36.

Distribution.—Fukien; Kwangtung; Hainan Island; Hongkong; Tonkin.

31. EUMECES CHINENSIS CHINENSIS (Gray).

Tiliqua chinensis GRAY, Ann. Nat. Hist. 2 (1838) 289, China.

Fifty-five specimens (Nos. 23542 to 23596, M. V. Z.) were collected: southwestern Fukien Province, 14 adults and 13 juveniles, from Gang-keu, altitude 450 to 550 meters, July 23 to 27; 1 juvenile from east of Haba, altitude 500 meters, July 18, 1936; southeastern Kiangsi Province, 7 adults from Hong San, altitude 600 to 700 meters, June 23 to 26; 1 adult from Kit-tan, altitude 500 meters; eastern Kwangtung Province, 12 juveniles from Tai-yong, altitude 650 meters, August 4 to 7; 5 adults from Mei-hsien (Kaying), altitude 200 meters, June 9 and 18; 1 specimen, seen but not caught, Tsin-leong San, altitude 826 meters.

Description.—Snout narrowed in front of eyes, rounded apically, longer than horizontal diameter of eye; rostral almost equilaterally triangular, separated from frontonasal by internasals; prefrontals more broadly in contact with frontal, frontonasal, and first loreals, than with each other, second loreals, and first two supraoculars; frontal one and one-half times as long as broad, slightly broader anteriorly than posteriorly; frontoparietals about as broad as long, larger than interparietal, which is longer than broad; parietals oblique, subrhomboidal; second loreal one and one-half times as long as deep; supralabials 7; infralabials 8 or 9; first two chin shields entire, third divided, fourth separated. Scales in 24 rows around body at middle; 55 to 60 scales in a row along midventral line from chin to vent. Adults dull brown above, brown and coppery red at sides, white on ventral surface; juveniles (to 130 millimeters long) black with three silvery, green, dorsal stripes on back and rows of spots on sides, head coppery tan with black sutures, labials largely white, tail steel-blue.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Total length.	Snout to vent.	Snout to ear.	Head width.	Axilla to groin.	Arm length.	Leg length.	Locality.
23585	female	184	66	14.0	10	32	15	22	Mei-hsien.
23550	male	237	88	17.0	13	38	24	34	Kit-tan.
23543	do	200	73	15.5	12	27	22	21	Hong Shan.
23546	female	219	89	20.0	16	43	24	37	Do.
23545	do	236	93	18.0	14	48	22	34	Do.
23542	do	204	75	16.0	12	39	22	30	Do.
23556	do	(172)	109	24.0	21	56	28	38	Gang-keu.
23560	do	269	101	20.0	14	57	28	35	Do.
23565	juvenile	112	44	6.5	7	24	11	18	Do.
23580	do	88	30	8.0	6	18	11	14	Haba.

Contents of nearly fifty stomachs examined (number in parentheses refers to number of stomachs contained in).—Crickets (7); spiders (7); caterpillars (6); scarabæid beetles of the subfamily Melolonthinæ (7); scarabæids of the genus *Euchlora*

(2); tenebrionid beetle (1); other beetles (4); snails (3); acridiid grasshoppers (2); tettigoniid grasshoppers (2); mole crickets (2); dragonfly nymphs (2); homopteran leafhopper (1); ranatran water bug (1); a belostomid water bug (*Sphæroderma*) (1); trichopteran and a chrysomelid beetle larva (?).

Not a single egg was found in any of the females.

Distribution.—Chekiang; Kiangsi; Hunan; Szechwan; Kwangsi; Kwantung; Hongkong; Hainan Island.

Local Hakka name.—*K'eu-ma sa.*

SERPENTES

COLUBRINÆ

32. NATRIX ÆQUIFASCIATA Barbour.

Natrix æquifasciata BARBOUR, Bull. Mus. Comp. Zool. 51 (1908) 317, Five Finger Mountains, Hainan Island.

Two specimens (Nos. 23615 and 23616, M. V. Z.) were taken in southeastern Kiangsi Province: 1 female, Sungwu, altitude 450 meters, July 12; 1 male, Hong San, altitude 800 meters, July 16, 1936.

Description (Nos. 23615 and 23616, respectively).—Very heavy-bodied, large; head swollen behind, preoculars 2—1, 2—1; postoculars 3—3, 3—4; suboculars 0—1, 1—1; upper labials 8; anterior temporals 1—2, 3—3; posterior temporals 3—3, 3—3; body scales keeled, outermost row weakly so, in 19 rows on neck and 17 rows at midbody and before vent; ventrals 152, 151; subcaudals (incomplete), 79. Total lengths, 780 millimeters (tail incomplete), 603; tails (110), 154. Brownish gray above, white below, with distinct bands on body and tail, encircling body but occurring alternately on ventral surface.

The stomach of the male contained three fish. The ovaries of the female contained over twenty eggs, the largest measuring about 28 by 13 millimeters.

Distribution.—Fukien; Kiangsi; Kwangsi; Kwangtung; Hainan Island.

Local Hakka name (Sungwu).—*Pak-ng Tou.*

33. NATRIX ANNULARIS (Hallowell).

Tropidonotus annularis HALLOWELL, Proc. Acad. Nat. Sci. Phila. 8 (1856) 151, Ningpo.

Four specimens (Nos. 23618 to 23621, M. V. Z.) were taken in eastern Kwangtung Province, at Tai-yong, altitude 650 meters, August 4 to 6, 1936.

New to Kwangtung Province.

Description.—Preoculars single; postoculars 3; anterior temporals 2; posterior temporals 3; supralabials 9—9 in three, 9—8 in No. 23618; infralabials 9. Body scales in 19 rows on neck and body and 17 before vent, keeled except on outermost rows. Grayish brown above; ventral surface red or yellow, with partially alternate black bands; labials narrowly edged with black.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Subcaudals.	Length.	Tail.	Bands.	
						Body.	Tail.
23618	female	156	66	337	69	39	21
23620	do	67	67	483	98	38	23
23619	male	161	incomplete	461	(54)	40	(9)
23621	female	157	69	660	139	39	21

The stomach of No. 23619 contained three small fish. The ovaries of No. 23621 held 8 eggs, 25 to 36 millimeters long, the four largest containing embryos 72 to 80 millimeters long.

Distribution.—Anhwei; Kiangsu; Fukien; Kiangsi; Kwangtung; Tonkin; Formosa.

34. NATRIX BOULENGERI Gressitt. Plate 1.

Natrix boulengeri GRESSITT, Proc. Biol. Soc. Wash. 50 (1937) 125–128.

Two female specimens were collected; the type, No. 23623 M. V. Z., in eastern Kwangtung Province, at Tai-yong, altitude 640 meters, August 5; and the paratype, No. 23622 M. V. Z., in southeastern Kiangsi Province, at Hong San, altitude 850 meters, June 30, 1936.

Description.—Neck slender; head broad behind middle; snout narrowed and truncate. Maxillary teeth 28 on right side in type, 28 and 29 in paratype. Rostral nearly one and one-half times as broad as deep; internasals as long as broad, narrowed apically, rounded externally; prefrontals one and one-fourth times as long as internasals, their dorsal portions nearly square; frontal one and one-half times as long as broad, barely longer than interparietal suture and barely longer than its distance from end of snout; supraoculars one-half as broad as, and slightly shorter than, frontal; parietals seven-twelfths as broad as long. Nasal nearly twice as long as deep; loreal one and two-thirds times as long as deep; preoculars single, a rudimentary suture crossing it in paratype, narrowed below; postoculars 2—2, lower postocular smaller; temporals 1—1—2 on each side, first temporal twice as long as second. Supralabials 9—9 in type, 8—8 in paratype, last three supralabials subequally large; mental broader than long, acute apically; infralabials 9—10 in type, first five infralabials in contact with anterior chin shields, the latter two-thirds as long as posterior pair. Body scales in 19 rows from one and one-half head lengths behind head to two to three head lengths beyond middle of body, in 17 rows before vent, finely keeled, except for the first row on each side. Ventrals 144 in type, 145 in paratype; anals divided; subcaudals 94 in paratype.

Total lengths 462 and 658 millimeters; tails (63) and 219, in type and paratype, respectively.

Largely gray and black above, with a pair of pale longitudinal dorsal stripes. Head dark brownish black, dorsal surface finely vermiculated with gray, a pair of small gray-white spots before middle of parietals; lower portions of nasal, loreal, and preocular partially mottled with gray; a striking, ivory-white stripe on each side, commencing on inferior postocular and upper hind corner of sixth supralabial, extending subobliquely to side and top of nape, from where it continues as one of the dorsal body stripes; first four supralabials black below, speckled above, fifth supralabial speckled anteriorly, black posteriorly, sixth supralabial largely black on upper half, speckled below; last three supralabials largely pure black except for ivory-white stripe crossing upper portions; infralabials partly black, partly white and black-speckled; chin shields partly spotted. Body gray-black to blue-black, finely speckled with white on sides, crossed by irregular bands formed of indistinct black spots; stripes pinkish brown, anteriorly composed of more or less joined elongate-oblong spots on seventh and eighth scale rows, posteriorly continuous stripes along fifth and sixth scale rows. Ventrals creamy white, each with a squarish black spot on each side, separated from external margin by a finely black-mottled area that on anterior ventrals forms a more or less distinct, narrow, light stripe.

The type contained three large elongate-oblong eggs, 22 to 29 millimeters long and 7 to 11 millimeters in diameter, with no evident embryos. The habitat is probably damp shady regions in the neighborhood of mountain streams and rice fields.

Distribution.—Northern and eastern Kwangtung and southern Kiangsi.

35. NATRIX PERCARINATA (Boulenger).

Tropidonotus percarinatus BOULENGER, Proc. Zool. Soc. London (1899) 163, pl. 17, Kuatun, Fukien.

Twenty-eight specimens (Nos. 23629 to 23656, M. V. Z.) were collected: southeastern Kiangsi Province, at Hong San, altitude 600 to 900 meters, June 22 to 30 and July 16: eastern Kwangtung Province, 2 at Yim-na San, altitude 500 meters, June 14; 2 at Tai-yong, altitude 650 meters, August 4: southwestern Fukien Province, 1 at Gang-keu, altitude 550 meters, July 23. Specimens were seen in rice fields at 900 meters altitude on Hong San.

Description.—Preoculars single; postoculars 4, 5, or 3; anterior temporals 2; posterior temporals 3—3 in twenty-five specimens, 3—4 in two specimens, and 2—3 in one specimen, supralabials 9, 8 on one side in two specimens and 10 on one side in one specimen, 3 before eye, 2 touching eye, and 4 behind eye in twenty-four specimens, the other four having the formulæ 4—1—4, 3—2—4 in No. 23644, 4—1—4, 3—2—3 in No. 23630, 3—2—5, 3—2—5 in No. 23650, and 3—2—4, 2—2—4 in No. 23652. Body scales in 19 rows from neck to midbody, 17 rows before vent; ventrals 135 to 143, subcaudals 76 to 84 in males, 70 to 81 in females, second and third subcaudals entire in No. 23639; largest female, 637 millimeters long from snout to vent; largest male, 448. Grayish brown with 29 to 37 black bands on body, indistinctly banded on tail; bands generally alternating along midventral line, but all except first four meeting in No. 23649 (juvenile).

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Subcaudals.	Total length.	Tail length.	Postoculars.	Body bands.
23629	female	137	77	673	189	4—5	25
23634	male	139	78	497	143	4—4	34
23645	do	141	76	588	160	4—4	37
23630	female	143	....	796	(159)	4—4	33
23642	do	137	81	753	211	4—5	34
23633	do	136	70	631	171	5—3	33
23638	do	140	73	426	117	4—4	29
23649	male	138	77	327	86	4—5	37
23650	female	139	80	725	210	5—5	34
23651	male	136	84	487	142	4—5	33

Stomachs of six specimens contained tadpole remains; stomachs of five others contained frog remains, three of which are referable to *Rana limnocharis* and one probably to *Rana spinosa;* stomachs of four others contained fish remains, one of which was

145 millimeters long; one stomach seemed to contain several very small bird embryos, suggesting that the snake had eaten eggs from a bird's nest. The ovaries of No. 23640 (Hong San, June 28) contained six small eggs.

Distribution.—Szechwan; Hupeh; Chekiang; Fukien; Kiangsi; Kwangsi, Kweichow; Kwangtung; Hainan Island.

Local Hakka name.—Fa-sam-bian.

36. NATRIX PISCATOR (Schneider).

Hydrus piscator SCHNEIDER, Hist. Amphib. 1 (1799) 247, East Indies.

Fourteen specimens (Nos. 23669 to 23682, M. V. Z.) were collected: eastern Kwangtung Province, 7 at Tai-yong, altitude 650 meters, August 4 and 5, 2 at Mei-hsien, altitude 225 meters, June 9 and 17: southwestern Fukien Province, 3 at Gang-keu, altitude 550 meters, July 24 and 25: southeastern Kiangsi Province, 1 at Hong San, altitude 600 meters, June 23; 1 at Sungwu, altitude 450 meters, July 13.

Description.—Preoculars single; postoculars 3, 4, or 5; anterior temporals 2, 3 on one side in one specimen; posterior temporals 2, 3 on one side in one case; supralabials 9—9 in thirteen cases, 10—8 in one case; scale rows 19—17—17; ventrals 127 to 129 in males, 140 to 147 in females; subcaudals 81 or 82 in males, 70 to 79 in females. The Tai-yong specimens are grayish brown to putty-gray, spotted with black; the two Mei-hsien specimens are olive-green and yellowish green, respectively, with the dark margins of ventrals very narrow.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Subcaudals.	Total length.	Tail length.	Postoculars.
23681	female	146	----------	740	(130)	3—3
23678	----do	140	79	727	194	4—4
23679	----do	145	73	632	158	3—3
23682	male	128	81	197	54	4—4
23674	female	143	70	645	172	3—3
23673	----do	144	72	652	164	3—4
23672	male	127	82	565	178	4—3

Two stomachs contained frog and tadpole remains, all of *Rana limnocharis;* two contained fish, those in one being a rainbow fish and an eel; the stomach of No. 23675 contained a pentatomid plant bug, and that of No. 23669 contained vegetable matter.

Distribution.—Chekiang; Fukien; Kiangsi; Kwangsi; Yunnan; Kwangtung; Hainan Island; also Formosa and India to the Malay Archipelago.

37. NATRIX SAUTERI (Boulenger).

Tropidonotus sauteri BOULENGER, Ann. & Mag. Nat. Hist. (8) 4 (1909) 495, Formosa.

Two specimens, both females, were collected: southeastern Kiangsi Province, No. 23685 M. V. Z., Hong San, altitude 950 meters, June 30; southwestern Fukien Province, No. 23686 M. V. Z., Gang-keu, altitude 500 meters, July 23.

New to Kiangsi Province.

Description.—Preoculars single; postoculars 3—3; anterior temporals 1—1 in both; posterior temporals 2—2, 1—2; supralabials 7—7 in both; body scales 17—17—17, outermost row very weakly keeled; ventrals 132, 129; subcaudals 71, 78. Mouse gray, No. 23685 slightly reddish; supralabials white, edged with black; nuchal white stripe extending from supralabials a short distance along neck, nearly converging; a row of small light spots along each side of dorsal surface; ventrals edged with black at either side, the spots forming almost continuous dark stripes.

Total lengths 380, 370 millimeters; tails 104, 110. No. 23686 was taken by a rice-fields irrigation ditch at the lower edge of a forest; its stomach contained an earthworm.

These specimens seem to differ slightly from Formosan specimens in having the nuchal white stripe arising from the supralabials instead of from the infralabials, the supralabials less regularly marked with black and the black spots at sides of ventrals forming a more continuous longitudinal stripe.

Distribution.—Formosa; Fukien; Kiangsi; Kwangtung; Kwangsi; Szechwan.

38. NATRIX STOLATA (Linnæus).

Coluber stolatus LINNÆUS, Syst. Nat. ed. 10 (1758) 219, "America."

Fifteen specimens (Nos. 23711 to 23725, M. V. Z.) were collected: eastern Kwangtung Province, 5 at Tai-yong, altitude 650 meters, August 4 to 6; 2 at Yim-na San, altitude 500 meters, June 12 and 15; southwestern Fukien Province, 6 at Gang-keu, July 24 to 26; southeastern Kiangsi Province, 2 at Hong San, altitude 600 to 800 meters, June 22 and July 15.

Description.—Preoculars single, 2 on one side in No. 23724; postoculars 3—3 in eleven specimens, 3—4 in three specimens, and 4—4 in one; anterior temporals single; posterior temporals 2—2 in twelve specimens, 2 on one side and 1 on the other in three specimens; supralabials 8—8 in all; body scales 19—17—17, keeled; ventrals 150 to 155 in males, 146 to 154 in females; subcaudals 77 to 81 in males, 70 to 78 in females.

Yellowish gray with a pair of dorsal stripes; head and neck reddish yellow; ventral surface creamy.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Locality.
23725	female	147	65	544	(128)	Tai-yong.
23724	do	153	70	632	143	Do.
23721	male	155	79	488	128	Do.
23722	do	152	81	536	143	Do.
23720	female	150	73	621	148	Yim-na San.
23713	do	148	73	547	132	Gang-keu.
23716	male	152	78	521	131	Do.
23718	female	152	71	205	49	Do.
23711	male	152	77	513	130	Hong San.

Stomachs of 4 specimens from Tai-yong and Gang-keu contained remains of *Rana limnocharis;* one of these also contained part of a scarabæid beetle of the genus *Euchlora,* possibly eaten by the frog. Ovaries of 2 females from Tai-yong contained ten and nine eggs, respectively, 17 to 18 millimeters long; 1 female from Hong San (June 22) held six eggs, averaging 22 millimeters in length; 1 female from Gang-keu (July 23) held seven eggs, measuring about 18 millimeters in length.

Distribution.—Chekiang; Fukien; Kiangsi; Kwangsi; Yunnan; Kwangtung; Hainan; Formosa; India; Burma; Siam; Malay Peninsula.

Local Hakka name.—Tso-fa Sa.

39. PSEUDOXENODON BAMBUSICOLA Vogt.

Pseudoxenodon bambusicola VOGT, Archiv Naturg. 88 A 10 (1922) 138, northern Kwangtung.

A single male specimen (No. 23747, M. V. Z.) southeastern Kiangsi Province, taken at Hong San, altitude 850 meters, June 23.

New to Kiangsi Province.

Description.—Head broad and flattened; supralabials 8; preoculars single; postoculars 3; anterior temporals 2; posterior temporals 3—2; body scales oblique, keeled, in 19 rows from neck to midbody and 15 before vent; ventrals 137; subcaudals 54. Light pinkish brown, yellowish on forebody, with twelve transverse brown bands on body and a pair of dorsal brown stripes commencing before middle of body and extending to tip of tail; labials yellow, nearly immaculate; a distinct black stripe behind each eye and a longer stripe on each side of neck as far as first transverse band; posterior portion of body and tail with a distinct light stripe just above ventrals and subcaudals, respectively.

Total length, 459 millimeters; tail, 89.

Distribution.—Fukien; Kiangsi; Kwangtung; Hainan Island.

40. OPISTHOTROPIS LATOUCHII (Boulenger).

Tapinophis latouchii BOULENGER, Proc. Zool. Soc. London (1899) 169, pl. 18, Kua-tun, Fukien.

Southeastern Kiangsi Province, 1 female (No. 23749, M. V. Z.), taken at Tai-au-hong, altitude 580 meters, July 6, near a stream.

Description.—Prefrontals single; loreals more than twice as long as deep, broadly in contact with eyes; no trace of preoculars; postoculars 2; temporals 1—1; supralabials 9—9; infralabials 8—7, first four in contact with anterior chin shields; body scales in 17 rows, weakly keeled on body, moderately keeled on tail. Ventrals 145; subcaudals 55. Gray-brown above, with a narrow black stripe between each two scale rows; yellowish white below, except for subcaudals which are all edged anteriorly and at either side with mottled brown; anterior supra- and infralabials brownish black, posterior supralabials dark above and light below.

Total length, 401 millimeters; tail, 80.

The stomach contained an earthworm 150 millimeters long.

Distribution.—Fukien, Kiangsi, and Kwangtung Provinces.

Local Hakka name.—*Nai Sa.*

41. OPISTHOTROPIS MAXWELLI Boulenger.

Opisthotropis maxwelli BOULENGER, Ann. & Mag. Nat. Hist. (8) 14 (1914) 483, southern Fukien.

Four specimens (Nos. 23750 to 23753, M. V. Z.) were collected: southeastern Kiangsi Province, 2 at Hong San, altitude 800 to 900 meters, June 30 and July 16: eastern Kwangtung Province, 1 at Yim-na San, altitude 550 meters, June 12: southwestern Fukien Province, 1 at Liung-chon San, altitude 780 meters, July 22.

New to Kiangsi and Kwangtung Provinces. Previously known only by the unique type from southern Fukien.

Description.—Snout broadly rounded-truncate, flattened, slightly projecting, four times as long as eye. Rostral one and one-half times as broad as deep; internasals oblique laterally, nearly twice as long as broad; nasal cleft dividing nasal into two unequal parts, below nostril extending to posterior corner of first supralabial; prefrontal single, more than twice as broad as long; frontal short, broader than long, three to four times as broad as each supraocular; parietals large, each over one and one-half as long, and fully as broad, as frontal. Loreal one and one-half to two times as long as deep; preoculars single; postoculars 2; anterior temporals single; posterior temporals 2, single on one side in No. 23751. Supralabials 7, first reaching posterior portion of nasal, fifth reaching eye, seventh as long as two preceding; infralabials 8 or 9; anterior chin shields longer and broader than posterior, touching first five infralabials. Scales in 17 rows throughout, smooth on neck, feebly keeled from before middle of body, moderately keeled on tail. Ventrals 158 and 160 in males, 151 and 153 in females; subcaudals 64 and 65 in males, 63 and 65 in females. Total length of largest specimen, 359 millimeters. Black above, including supra- and infralabials, yellow-orange beneath; subcaudals partly black at sides, yellow along middle to just anterior to tip of tail.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Locality.
23750	female	153	63	359	79	Hong San.
23751	do	151	65	348	99	Do.
23753	male	160	65	349	76	Yim-na San.
23752	do	158	64	359	78	Liung-chon San.

The stomach of No. 23751 contained remains, probably of an insect larva. In No. 23750 the third to sixth subcaudals are entire.

Distribution.—Southern and western Fukien; southeastern Kiangsi; eastern Kwangtung.

42. ZAOCYS DHUMNADES MONTANUS Pope.

Zaocys dhumnades montanus POPE, Amer. Mus. Novitates 325 (1928) 2, Chungan-hsien, Fukien.

A single female specimen (No. 23759, M. V. Z.) was taken in southeastern Kiangsi Province, Hong San (northeast slope), altitude 840 meters, July 14, 1936.

This is the first Kiangsi record for this subspecies.

Description.—Head narrow, slightly wider than neck; dorsal head plates large, frontal transverse anteriorly, parietals truncate behind; 2 pre- and 2 postoculars; eye nearly as long as its distance from tip of snout; temporals 2—2; supralabials 8;

body scales in 16 rows on neck, 14 at midbody and before vent, 2 middle rows keeled except on neck; ventrals 202; subcaudals 120. Light brown on head, orange-brown along dorsal surface of anterior part of body, a wide black stripe along either side of vertebral line; lower sides and ventrals pale bluish, edged with black.

Total length 1,360 millimeters; tail 409 (incomplete).

The ovaries contained a single, flattened, oblong-oval egg, 31 by 13 millimeters.

Distribution.—Fukien; Kiangsi; Kwangtung; Hunan; Kwangsi; Szechwan; Tonkin.

Local Hakka name.—Han-nan Sa.

43. PTYAS KORROS (Schlegel).

Coluber korros SCHLEGEL, Phys. Serp. 2 (1837) 139, Java.

Two male specimens (Nos. 23761 and 23762, M. V. Z.) represent this species; the former was collected in southeastern Kiangsi Province, Hong San, altitude 650 meters, June 22, 1936; the latter in eastern Kwangtung Province, Mei-hsien (Kaying), altitude 200 meters, June 9.

Description (Nos. 23762 and 23761, respectively).—Loreals 3; preoculars 2; postoculars 2; anterior temporals 2—2; posterior temporals 2—2, 2—3; supralabials 8; 5 infralabials in contact with anterior chin shields. Body scales keeled posteriorly in the former, smooth in the latter, in 15 rows on neck, 11 rows at midbody, and 11 rows before vent in 23762 and 15—13—11 in 23761. Ventrals 167 and 162; subcaudals 121 and 123. Brown above, striped with darker along middle of each scale row from before midbody; ventral surface white, bluish at sides.

Total length, 1,370 and 1,208 millimeters; tails, 452 and 419.

The stomachs contained several *Rana limnocharis* and the larva of a water beetle of the family Dytiscidæ.

Distribution.—South China; Hainan Island; Formosa; eastern Himalayas to Malay Archipelago.

44. PTYAS MUCOSUS (Linnæus).

Coluber mucosus LINNÆUS, Syst. Nat. ed. 10 (1758) 226, "Indiis."

Two specimens were collected: eastern Kwangtung Province, 1 male (No. 23769, M. V. Z.) at Mei-hsien (Kaying), altitude 220 meters, June 9, 1936; 1 female (No. 23770, M. V. Z.) at Kakchieh, Swatow, August 24.

Description (23769 and 23770, respectively).— Loreals 3; preoculars 2; postoculars 2; anterior temporals 2—2; posterior temporals 2—3, 2—2; supralabials 8; scale rows 19—17—14; ventrals 196, 192; subcaudals 118, 112. Dull brown above, narrowly and irregularly banded with black posteriorly; labials light, edged posteriorly with black; ventrals yellow, edged with black at sides of posterior margins on neck and posterior portion of body; subcaudals similarly marked.

Total lengths 1670, 1850 millimeters; tails 415, 443.

The stomach of No. 23769 contained a *Rana rugulosa* and a crab; that of No. 23770 a frog and some plant material.

Distribution.—Eastern and southern China; Tibet; Transcaspia and Afghanistan south to Ceylon and east and south to the Malay Archipelago.

45. EURYPHOLUS MAJOR (Guenther).

Cyclophis major GUENTHER, Cat. Colubr. Brit. Mus. (1858) 120, near Ningpo.

Eight specimens (Nos. 23786 to 23793, M. V. Z.) were collected: eastern Kwangtung Province, 1 at Yim-na San, altitude 550 meters, June 14; 2 at Tai-yong, altitude 650 meters, August 4 and 5, 1936: southeastern Kiangsi Province, 3 at Hong San, altitude 800 to 900 meters, June 26 to 30; 1 at Tai-au-hong, altitude 520 meters, July 4: southwestern Fukien Province, 1 at Liung-chon San, altitude 650 meters, July 22.

Description.—Slender; head narrow; snout nearly pointed; body scales smooth, in 15 rows from neck to vent. Body grass-green above, pale yellowish green beneath, except for No. 23787 which (in alcohol) is dull grayish blue above with the anterior two-thirds of each ventral the same color except on the neck, where they are white. No. 23789 has the supralabials 4—6, the others all 8—8. No. 23786 has an extra scale on each side between lower postocular, anterior temporal and fifth to seventh supralabials; its color does not differ from that of the larger specimens, though its length is only 312 mm.

No. 23788 contained six eggs, measuring 18 to 20 millimeters in length and 8 to 10 millimeters in diameter, in an early stage of development (July 4). Some of the snakes were found on the ground in bamboo forests; one hid under some rocks while trying to escape; another was found in a vine in a shrub one and one-half meters above the ground. The stomachs contained earth or the remains of earthworms.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Locality.
23792	male	161	95	785	218	Tai-yong.
23790	do	166	89	750	200	Yim-na San.
23789	do	154	82	690	190	Tai-au-hong.
23791	femele	168	81	684	161	Tai-yong.
23793	do	161	81	640	179	Liung-chon San.
23788	male	167	88	617	160	Hong San.
23787	female	165	80	593	147	Do.
23786	male	162	90	312	78	Do.

Distribution.—Szechwan; Hupeh; Kiangsu; Chekiang; Fukien; Kiangsi; Hunan; Kwangtung; Tonkin; Formosa.

Local Hakka name.—Chan-liuk Sa.

46. HOLARCHUS FORMOSANUS (Guenther).

Simotes formosanus GUENTHER, Ann. & Mag. Nat. Hist. (4) 9 (1872) 20, Takao, Formosa.

A single male specimen (No. 23799, M. V. Z.) was taken in southeastern Kiangsi Province, Hong San, altitude 900 meters, June 30, 1936, near the edge of the forest.

Description.—Cylindrical; head short, hardly distinct from neck; snout very blunt. Rostral large; supralabials 8, oculars 2—2, and temporals 1—2 on each side; body scales smooth, in 19 rows at neck and midbody and 16 before vent; ventrals 160; tail incomplete. Light brown above with dark-brown bands; head distinctly marked with two oblique stripes on each side and an inverted V on occiput.

Total length, 511 millimeters; snout to vent, 445.

The stomach of this specimen contained remains which were probably those of insect larvæ.

Distribution.—Chekiang; Kiangsi; Fukien; Kwangtung; Kwangsi; Hainan Island; Tonkin; Formosa.

47. HOLARCHUS VIOLACEUS (Cantor).

Coronella violacea CANTOR, Proc. Zool. Soc. London (1839) 50, Rangpur, Bengal.

A single female specimen (No. 23801, M. V. Z.) was taken in eastern Kwangtung Province, Yim-na San, altitude 550 meters, June 13.

Description.—Head short, truncate; rostral large; preoculars 1—1; postoculars 2—2; temporals 2—2, 2—3; supralabials 10—10; body scales smooth, in 17 rows at neck and midbody and

15 before vent. Ventrals 166; subcaudals 33, all but second to sixth divided. Reddish orange above, pinkish white beneath.

Total length, 470 millimeters; tail, 59.

The stomach of this specimen contained seven tarantulid spiders.

Distribution.—Eastern Bengal and Cambodia through Burma and Tonkin to Kwangtung, Fukien, and Hainan Island.

Local Hakka name.—Bu-kian Sa.

48. CALAMARIA SEPTENTRIONALIS Boulenger.

Calamaria septentrionalis BOULENGER, Proc. Zool. Soc. London (1890) 34, Kiu-kiang region and Hongkong.

A single female specimen (No. 23803, M. V. Z.) was procured in southeastern Kiangsi Province, Sungwu, altitude 450 meters, in July.

Description.—Small, of uniform diameter throughout; tail very short and blunt. Frontal as broad as long; prefrontals very large; no internasals, temporals, or loreal; supralabials 4—4; scales smooth, short, in 13 rows throughout; ventrals 175; anal entire; subcaudals 9. Brownish black above; ventral surface and an incomplete band on neck and another at base of tail, red; undersurface of tail black along middle.

Total length, 159 millimeters; tail, 6.

Distribution.—Anwei; Chekiang; Fukien; Kwangtung; Kiangsi; Hunan; Kwangsi; Hainan Island; Tonkin.

Local Hakka name.—Leong-teu Sa (two-headed snake).

HOMALOPSINÆ

49. ENHYDRIS CHINENSIS (Gray).

Hypsirhina chinensis GRAY, Zool. Misc. (1842) 66, China.

Ten specimens (Nos. 23813 to 23822, M. V. Z.) were collected: southwestern Fukien Province, 6 from Gang-keu, altitude 525 meters, July 24 to 27: southeastern Kiangsi Province, 2 from Hong San, altitude 825 meters, June 28 to 30: eastern Kwangtung Province, 2 from Mei-hsien (Kaying), altitude 220 meters, June 7 and 8, 1936.

Description.—Internasal single; oculars 1—2; temporals 1—2; supralabials 8; body scales in 23 to 25 rows anteriorly and 19 before vent; ventrals 142 to 154; subcaudals 40 to 51. Gray above with side of ventrals and subcaudals black along their anterior margins; supralabials black above, yellow below.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Locality.
23821	female	142	42	605	78	Mei-hsien.
23822	male	154	51	279	44	Do.
23814	female	142	40	281	37	Hong San.
23813	do	145	41	454	56	Do.
23816	do	144	42	387	51	Gang-keu.
23815	male	149	44	303	42	Do.
23818	do	145	44	365	50	Do.

One stomach contained the remains of a frog, another those of a fish. No. 23821 contained twelve eggs 23 by 15 millimeters, with embryos measuring about 50 millimeters in length, still unpigmented. The ovaries of No. 23813 held five eggs, measuring 17 by 14 millimeters.

Distribution.—Eastern and southern China; Hainan Island; Formosa.

50. ENHYDRIS PLUMBEA (Boie).

Homalopsis plumbea BOIE, Isis (1827) 550, Java.

Ten specimens (Nos. 23844 to 23853, M. V. Z.) were collected: southwestern Fukien Provinces, 8 at Gang-keu, altitude 550 meters, July 24 to 26: southeastern Kiangsi Province, 2 at Hong San, altitude 625 to 750 meters, June 23 and July 17, 1936.

New to Kiangsi Province.

Description.—Internasal triangular; preoculars 2; anterior temporals single; posterior temporals 2 or 3; supralabials 8, first supralabial extending posteriorly above; body scales smooth, in 19 rows from neck to midbody, in 17, 16, or 15 before vent. Greenish black or greenish brown above, yellowish along middle of side and creamy white below, with a small black spot at middle of each ventral, median sutures of subcaudals black; labials largely white.

Measurements of selected specimens, in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Locality.
23844	female	127	35	300	35	Hong San.
23845	do	129	38	201	26	Do.
23846	do	125	37	320	29	Gang-keu.
23851	do	127	37	328	39	Do.
23852	male	126	41	279	38	Do.
23853	female	126	36	289	38	Do.

Contents of three stomachs included a *Rana limnocharis*, a fish, and a crustacean (?) respectively. The ovaries of No. 23846 contained eggs with five young measuring 89 to 92 millimeters in length, fairly well pigmented.

Distribution.—Chekiang; Kiangsi; Fukien; Kwangtung; Hainan Island; Formosa; Burma and Tonkin, south into the Malay Archipelago.

Local Hakka name.—*Mei Sa.*

BOIGINÆ

51. BOIGA MULTOMACULATA (Boie).

Dipsas multomaculata BOIE, Isis (1827) 549, Java.

Four specimens (Nos. 23865 to 23868, M. V. Z.) were collected: southwestern Fukien Province, 1 at Gang-keu, altitude 575 meters, July 25, 1936; eastern Kwangtung Province, 2 at Mei-hsien, altitude 220 meters, in the summer of 1935 by Miss Erichson, and in June, 1936, by the Rev. Mr. David M. Campbell, respectively; 1 at Kakchieh, Swatow, altitude 50 meters, July, 1936, by the Rev. Mr. A. H. Page.

Description.—Slender, anterior portion of body and neck very narrow, head broad; tail slender. Preoculars single in three specimens, double in one; postoculars 2; anterior temporals 2; posterior temporals 3; supralabials 8; body scales in 19 or 20 rows on neck, 19 at midbody and 13 or 14 before vent, vertebral row slightly enlarged; ventrals 197 to 203; subcaudals 82 to 90. Light speckled brown, with a row of large, transverse, dark-brown spots on either side, with irregular rows of smaller spots on lower sides and ventral surface; head with an arrow-shaped mark on top and a dark laterial line; labials dark, edged posteriorly with brown.

Measurements of 4 males, in millimeters.

M. V. Z. No.	Ventrals.	Subcaudals.	Total length.	Tail length.	Locality.
23865	200	90	403	84	Gang-keu.
23866	197	....	620	(97)	Mei-hsien.
23867	203	82	490	95	Do.
23868	197	87	370	74	Swatow.

The stomach of the specimen from Swatow contained the remains of a gecko (*Hemidactylus bowringii*).

Distribution.—Fukien; Kiangsi; Kwangsi; Kwangtung; Hainan Island; Bengal and Burma to Celebes.

Local Hakka name.—*Bak-po-chen.*

ELAPIDÆ

52. BUNGARUS MULTICINCTUS MULTICINCTUS Blyth.

Bungarus multicinctus BLYTH, Journ. Asiat. Soc. Bengal 29 (1861) 98, Amoy.

Three specimens (Nos. 23872 to 23874, M. V. Z.) were obtained: eastern Kwangtung Province, two half-grown specimens at Mei-hsien (Kaying), altitude 225 meters, June 9 and 17: southeastern Kiangsi Province, 1 adult near Tai-au-hong, altitude 580 meters, July 6, 1936.

Description.—Body slender, deeper than wide; middorsal scale row enlarged and raised; head narrower than body at middle, very little wider than neck. Loreal absent; eyes shorter than one-half their distance from snout, pupil subcircular; oculars 1—2; labials 7; body scales smooth, in 15 rows from neck to vent. Body shiny bluish black above with many narrow, creamy-white bands; ventral surfaces dull cream, broadly banded with black on tail, ventrals irregularly speckled in the two larger specimens.

Measurements of 3 females, in millimeters.

M. V. Z. No.	Ventrals.	Subcaudals.	Total length.	Tail length.	White bands on—	
					Body.	Tail.
23872	215	49	570	71	42	14
23873	209	51	623	80	35	11
23874	206	50	1,120	134	35	10

The stomach of No. 23873 contained the remains of an eel over 200 millimeters long. One of the smaller specimens, released accidentally in a room in daylight, was exceedingly active in trying to escape.

Distribution.—Chekiang; Fukien; Kiangsi; Kwangtung; Hunan; Hupeh; Kwangsi; Hainan Island; Formosa.

Local Hakka name.—Bo-ki-kap.

English name.—Chinese krait.

53. NAJA NAJA ATRA Cantor.

Naja atra CANTOR, Ann. & Mag. Nat. Hist. (1842) 482, Chusan Island.

Five specimens were taken (Nos. 23883 to 23887, M. V. Z.), all in eastern Kwangtung Province: 2 at Mei-hsien city (Kaying), altitude 225 meters, June 8 and 9; 1 at Yim-na San, altitude 550 meters, June 21, and 2 at Kakchieh, Swatow, altitude 50 meters, July 27 and August 9, 1936.

Description.—Rostral triangular; internasal suture shorter than prefrontal; parietals very broad, emarginate posterolaterally; nostril vertical; loreal absent; preoculars single; postoculars 1 (5 specimens), 2 (3 specimens), or 3 (2 specimens); anterior temporals 2; posterior temporals 2 on each side in two specimens, 2 on one side and 3 on other in three; body scales in 24 to 26 rows on neck, 21 or 20 rows at midbody, and 15 or 16 rows before vent; ventrals 157 to 173; subcaudals 45 to 50. Black, narrowly and distinctly banded with white; back of spreading neck with white spectacles or a mask; anterior ventrals white, remainder iridescent silvery black.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Sub-caudals.	Total length.	Tail length.	Bands.	Locality.
23884	male	157	47	522	82	17	Mei-hsien.
23885	do.	168	48	519	78	22	Do.
23883	female	173		1,015	(139)	17	Yim-na San.
23886	do.	174		656	(93)	11	Swatow.
23887	male	165	50	1,065	161	6	Do.

Two stomachs contained a young *Bufo melanostictus* and the skull of a fish, respectively.

Distribution.—Kwangsi; Hunan; Kiangsi; Chekiang; Fukien; Kwangtung; Hongkong; Hainan Island; Formosa; Tonkin.

Local Hakka name.—*Fan-chok Sa* (rice-ladle snake).

English name.—Chinese cobra.

AMBLYCEPHALIDÆ

54. AMBLYCEPHALUS KUANGTUNGENSIS Vogt.

Amblycephalus kuangtungensis VOGT, Archiv Naturg. 88 A 10 (1922) 141; MELL, ibid., 125.

A single specimen (No. 23890, M. V. Z.), a juvenile, was taken in eastern Kwangtung Province, Tai-yong, altitude 660 meters August 6, 1936.

Description.—Neck slender; head large, subrectangular; snout short, broad, truncate. Preoculars 3—2; postoculars 3—3; anterior temporals 2—2; posterior temporals 3—3; supralabials 6—6; body scales 14—14—14; scales of two middle rows enlarged; ventrals 184; subcaudals 69. Pale whitish tan, with about 48 irregular, transverse, narrow, dark-brown bands on each side of body and about 30 less regular bands on tail; snout and labials white; top of head mottled black; ventrals dirty cream, sparsely and finely dotted with dark brown.

Total length, 179 millimeters; tail, 39.

The stomach contained remains which were probably those of a small slug.

Distribution.—Fukien; Kwangtung; Kwangsi.

CROTALIDÆ

55. TRIMERESURUS ALBOLABRIS Gray.

Trimeresurus albolabris Gray, Zool. Misc. (1842) 48, China.

Three specimens were collected (Nos. 23901 to 23903, M. V. Z.) southwestern Fukien Province, 2 at Gang-keu, altitude 540 meters, July 27 and 28; eastern Kwangtung Province, 1 at Tai-yong, altitude 650 meters, August 4, 1936.

Description.—Body short; neck slender; head broad behind; internasals and supraoculars large, remaining scales on top of head very small; first labial partly fused with nasal; second supralabial forming anterior border of pit; third supralabial largest; supraoculars separated by 9, 10, and 11 scales, respectively; body scales keeled, in 21, 23, and 25 rows on neck, 21 at midbody, and 15 before vent. Green above, with many indistinct black bands on dorsum; greenish white below with a longitudinal white line on each side commencing on rostral and extending along side of head, touching lower edge of eye, and along upper portions of first scale row on body.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Subcaudals.	Total length.	Tail length.	Locality.
23901	male	151	63	419	70	Gang-keu.
23902	do.	158		415	(71)	Do.
23903	female	165	52	685	93	Tai-yong.

The stomachs of the two Gang-keu specimens contained remains of frogs, probably of *Rana limnocharis.*

Distribution.—Fukien; Kwangsi; Kwangtung; Hongkong; Hainan Island; Formosa.

Local Hakka name.—Tsuk Sa.

56. TRIMERESURUS MUCROSQUAMATUS (Cantor).

Trigonocephalus mucrosquamatus CANTOR, Proc. Zool. Soc. London (1839) 32, Assam.

Four specimens were collected (Nos. 23908 to 23911, M. V. Z.) : southwestern Kiangsi Province, 3 from Hong San, altitude

850 to 1,050 meters, June 27 and 30 and July 16: southern Kiangsi Province, 1 from Ng-tze San, altitude 675 meters, above Wong-sa-shue, July 9, 1936.

Description.—Body fairly long; neck slender; head broad behind, narrowed before middle; scales on top of head small, 15 or 14 in a row between supraoculars; several scales between nasal and "pit"; pupil vertical; fangs long, two on left side in No. 23908. Pinkish brown to rusty brown, with 60 to 70 bands, each consisting of a large dorsal, and a pair of smaller, lateral, dark-brown spots which are blackish near their edges and partly margined with white. The smallest specimen is pale pinkish tan on top of head, the largest rusty brown.

Measurements in millimeters.

M. V. Z. No.	Sex.	Ventrals.	Subcaudals.	Total length.	Tail length.	Body scales at—		
						Neck.	Middle.	Vent.
23908	female	210	85	828	142	27	25	19
23909	male	212	90	696	123	27	25	19
23910	female	213	77	830	135	27	25	19
23911	do	210	84	408	69	28	28	21

The stomach of No. 23910 held a large rat. No. 23908 was found under a boulder in a jungle at 1,050 meters altitude. It refused to strike when captured. Its stomach contained the remains of a rodent with a tail 165 millimeters long. No. 23911 was found under a pile of brushwood by a house. This species was not mentioned from Kiangsi by Pope in 1935, and was first recorded from this province by M. L. Y. Chang in 1934.

Distribution.—Fukien; Kiangsi; Kwangtung; Kwangsi; Szechwan; Formosa; Tonkin; Burma; Assam.

TESTUDINATA

PLATYSTERNIDÆ

57. PLATYSTERNON MEGACEPHALUM Gray.

Platysternon megacephalum GRAY, Proc. Zool. Soc. London (1831) 107, China.

Three specimens (Nos. 23926 to 23928, M. V. Z.) are in the collection: southern Kiangsi Province, 1 from Tai-au-hong, altitude 700 meters, July 5: eastern Kwangtung Province, 2 from Tai-yong, altitude 640 meters, August 4. An additional specimen, original No. 883, was procured in southern Kiangsi Province, Hong San, altitude 660 meters, June 23, but died and was eaten by a servant at Sungwu during my trip to Tai-au-hong. New to Kiangsi Province.

Description.—Body dorsoventrally strongly compressed; carapace oblong, rather plane, weakly unicarinate; head very large, one-half as broad as, and nearly one-half as long as, carapace; slightly emarginate posteriorly; tail nearly as long as carapace. Brown above, mottled with yellow-brown and black; plastron dirty yellow-brown; head streaked above; moderate-sized specimens with head spotted with orange-brown laterally and ventrally, and with neck, legs, and underside of base of tail spotted with pink or dirty white. Small specimen with a dirty white, black-edged stripe from eye to neck; lower parts of head and neck pale, with black dots.

Measurements in millimeters.

M. V. Z. No.	Carapace.		Shell depth.	Platron length.	Tail length.	Locality.
	Length.	Breadth.				
23926	122	91	36	99	110	Tai-au-hong.
23927	100	69	28	87	93	Tai-yong.
23928	125	84	37	101	120	Do.

Original No. 883 from Hong San (lost) measured about 180 millimeters in length of carapace, which is near the maximum size for this species, No. 1482 was taken to the United States alive, but died after nearly five months, having refused to eat snails or earthworms, which are part of its normal diet.

Distribution.—Kwangtung; Kwangsi; Kiangsi; Fukien; Indo-China; Siam; southern Burma.

Local Hakka name (Tai-yong).—Bak-lo-kui.

TESTUDINIDÆ

58. CYCLEMYS TRIFASCIATA (Bell).

Sternothærus trifasciatus BELL, Zool. Journ. Lond. 2 (1825) 305, pl. 14 (13).

A single female specimen (No. 23933, M. V. Z.) was brought at Swatow, Kwangtung Province, August 28. An additional specimen was seen in the same market.

Description.—Carapace broader behind, feebly tricarinate; plastron notched posteriorly, hinged laterally and between pectoral and abdominal plates. Head yellow above, below and on lower parts of sides, upper lateral portion dark brown, a yellow-brown stripe passing through eye; carapace dull brown, carinæ black; plastron black, margins partly yellow, median area yellow-brown.

Measurements.—Length of carapace, 127 millimeters; width of carapace, 94; depth of shell, 47; length of plastron, 119; length of tails, 25.

Distribution.—Kwangtung, Hainan Island, Kwangsi.

59. **CLEMMYS BEALEI** (Gray).

Cistudo bealei GRAY, Synop. Rept. (1831) 71, China.

A single male specimen (No. 23936, M. V. Z.) of this rare species was purchased at Gang-keu, southwestern Fukien Province, July 22.

Description.—Carapace feebly unicarinate, broader behind; plastron transversely truncate anteriorly, slightly emarginate posteriorly, anal suture slightly longer than pectoral and femoral, and nearly as long as abdominal, suture. Head with four eyelike spots on temporal region, anterior spot on each side oval, vaguely defined, olive-brown, with one central, and several peripheral, black spots, posterior "eye" round, red, with black center; sides and anterior portion of head olive with black vermiculations; maxilla and mandible vertically streaked with yellow; neck with three dorsal, and many ventral, red stripes; legs brown above, yellowish white below; carapace olive-green, streaked or spotted with black anteriorly, more brownish near posterior end; plastron pinkish with a very few brown streaks. The red and pinkish changed to dirty yellow in alcohol. The shell of this specimen could hardly be said to be vermiculated, particularly below.

Measurements.—Length of carapace, 118 millimeters; breadth of carapace, 85; depth, 38; length of plastron, 102, tail, 31.

Distribution.—Fukien Province.

60. **CLEMMYS MUTICA** (Cantor).

Emys muticus CANTOR, Ann. & Mag. Nat. Hist. 9 (1842) 482, Chusan Island, Chekiang.

Two specimens (Nos. 23937 and 23938, M. V. Z.) were purchased at Swatow, Kwangtung Province, August 28. This species was most numerous among a lot of hard-shelled turtles brought to me there. The two bought were the largest and smallest, respectively, of the lot. This species has not previously been recorded from Kwangtung Province, and is not known from Fukien Province. No. 23937 had evidently been previously kept in captivity, as one of its hind legs had been amputated and healed. Though this might suggest introduction, the species is quite likely indigenous, as it has already been recorded from Hainan Island and Formosa.

Description.—Larger specimen, 23937: Carapace oblong-oval, nearly as broad anteriorly as posteriorly, feebly unicarinate, flattish in middle, second and third neural plates nearly rectangular; plastron concave in middle, truncate anteriorly and strongly emarginate posteriorly, longitudinal sutures not varying much in length, abdominal suture longest. Greenish olive on top of head, yellowish white below, a greenish yellow stripe extending back from eye; legs black above; shell largely black, carapace partly brownish at sides, plastron with a few yellow splotches. Smaller specimen, 23938: Carapace serrate behind, with a strong median, and feeble lateral, carinæ, three middle neurals strongly angulate laterally; plastron slightly emarginate anteriorly, deeply so posteriorly. Color of head as in 23937; carapace chocolate-brown; plastron dirty yellow, each plate with a large, brownish-black blotch on outer part, touching posterior margin; tail light with sides grayish black.

Measurements, 23937 and 23938, respectively.—Length of carapace, 187, 115 millimeters; width of carapace, 132, 83; depth, 53; length of plastron, 163, 101; tail, 33, 31.

Distribution.—Anhwei; Kiangsu; Chekiang; Kwangtung; Formosa; Hainan Island.

61. GEOCLEMYS REEVESI (Gray).

Emys Reevesi GRAY, Synop. Rept. (1831) 73, China.

A single specimen (No. 23939, M. V. Z.), a male, was taken from a swimming pool at Kakchieh, across the river from Swatow, eastern Kwangtung Province, August 27.

Description.—Body fairly deep; carapace oblong-oval, slightly broader posteriorly, plastron truncate anteriorly, deeply emarginate posteriorly, abdominal plates longest. Head grayish green with two narrow, longitudinal, slightly sinuous yellow stripes on each side, the upper stripe continued onto neck; tympanum bordered with a similar line; throat spotted, undersides of neck striped with yellow; carapace reddish brown; plastron blackish brown, sutures narrowly yellow; legs largely gray with a few yellow spots.

Measurements.—Length of carapace, 154 millimeters; breadth, 106; depth, 65; length of plastron, 144; tail, 30.

Distribution.—Most of China (perhaps introduced into the South from the North); Korea; southern Japan.

62. OCADIA SINENSIS (Gray).

Emys sinensis GRAY, Proc. Zool. Soc. London (1834) 53, China.

A single specimen (No. 23943, M. V. Z.), a female, was purchased at Swatow, eastern Kwangtung Province. Additional captive specimens were seen there.

Description.—Carapace oval, strongly arched, broadest behind middle, tricarinate, lateral carinæ feeble; plastron transversely subsinuate-truncate anteriorly, rounded-emarginate posteriorly, abdominal plates largest. Head and neck black, longitudinally striped with yellow, except on middle of top of head, sides of head broadly striped, gula and ventral surface of neck pale yellow with fine black lines; carapace dull reddish brown, sutures black; plastron dirty yellowish white, each plate with central portion light chocolate brown; legs and tail largely black with yellow stripes above, and yellow, striped, or ocellated, below, with black.

Measurements.—Length of carapace, 153 millimeters; breadth, 110; depth, 57; length of plastron, 141; tail, 46.

Distribution.—Formosa; Hainan; Kwangtung; Annam.

TRIONYCHIDÆ

63. TRIONYX SINENSIS Wiegmann.

Trionyx (Aspidonectes) sinensis WIEGMANN, Nova Acta Leop. Carol. 17 (1835) 189, small Island in Tiger River, near Macao.

Eleven specimens (Nos. 23947 to 23957, M. V. Z.) were taken: eastern Kwangtung Province, 2 purchased at Mei-hsien (Kaying, Moejen), altitude 230 meters, May 30: southeastern Kiangsi Province, 7 (23947 to 23953), purchased near Hong San, altitude 600 meters, June 21: southwestern Fukien Province, 2 carapaces (23954 and 23955), procured between Shanghang and Liung-chon San and at Gang-keu, respectively, in July. No. 23956 was skeletonized. Fukien Province, 3 very nearly spherical, white, hard-shelled eggs, measuring 19 to 20.5 millimeters in diameter, were brought to me at Gang-keu, July 24. They contained no evident embryos.

Description.—Nostrils produced into a fleshy snout; lips fleshy; neck granulated; body greatly depressed; bony carapace covered with a fleshy dorsal shield (disc) extending beyond ribs; plastral bones incomplete, loosely jointed, covered with skin; disc with a raised anterior margin, sublongitudinally ridged over most of surface with rows of narrow tubercles, more prominently in smaller individuals, skin covering bony carapace closely vermiculated, skin behind carapace grossly and densely tuberculate. Largely putty-gray above and white beneath, bluish or mottled on underside of head, neck, hands, and feet. Even the smallest specimen (72 millimeters) lacks the black ventral blotches characteristic of juveniles from farther north.

Measurements of 9 specimens, in millimeters.

M. V. Z. No.	Sex.	Carapace length.	Disc.		Depth of body.	Plastron length.	Tail, from leg.
			Body length.	Width.			
23954		132					
23948		110	169	127	38	121	67
23850		77	123	98	37	109	39
23947	female	70	117	90	31	93	36
23949	male	70	115	89	23	89	43
23957		70	110	78	29	89	31
23952		57	94	76	24	75	31
23953		56	90	74	24	75	26
23951	male	43	72	61	18	60	23

Distribution.—All of China except the highest parts in the west; Hainan; Formosa; probably also Japan and eastern Siberia.

Local Hakka name.—Toi-ng.

ILLUSTRATION

PLATE 1

[Drawing prepared by T. P. Maslin.]

Natrix boulengeri Gressitt, 23623, M. V. Z., female, from Tai-yong, altitude 540 meters, eastern Kwangtung Province. Tracings on photographs. × 3 ½. FIG. 1, dorsal view of head; *2*, ventral view of head; *3*, lateral view of head.

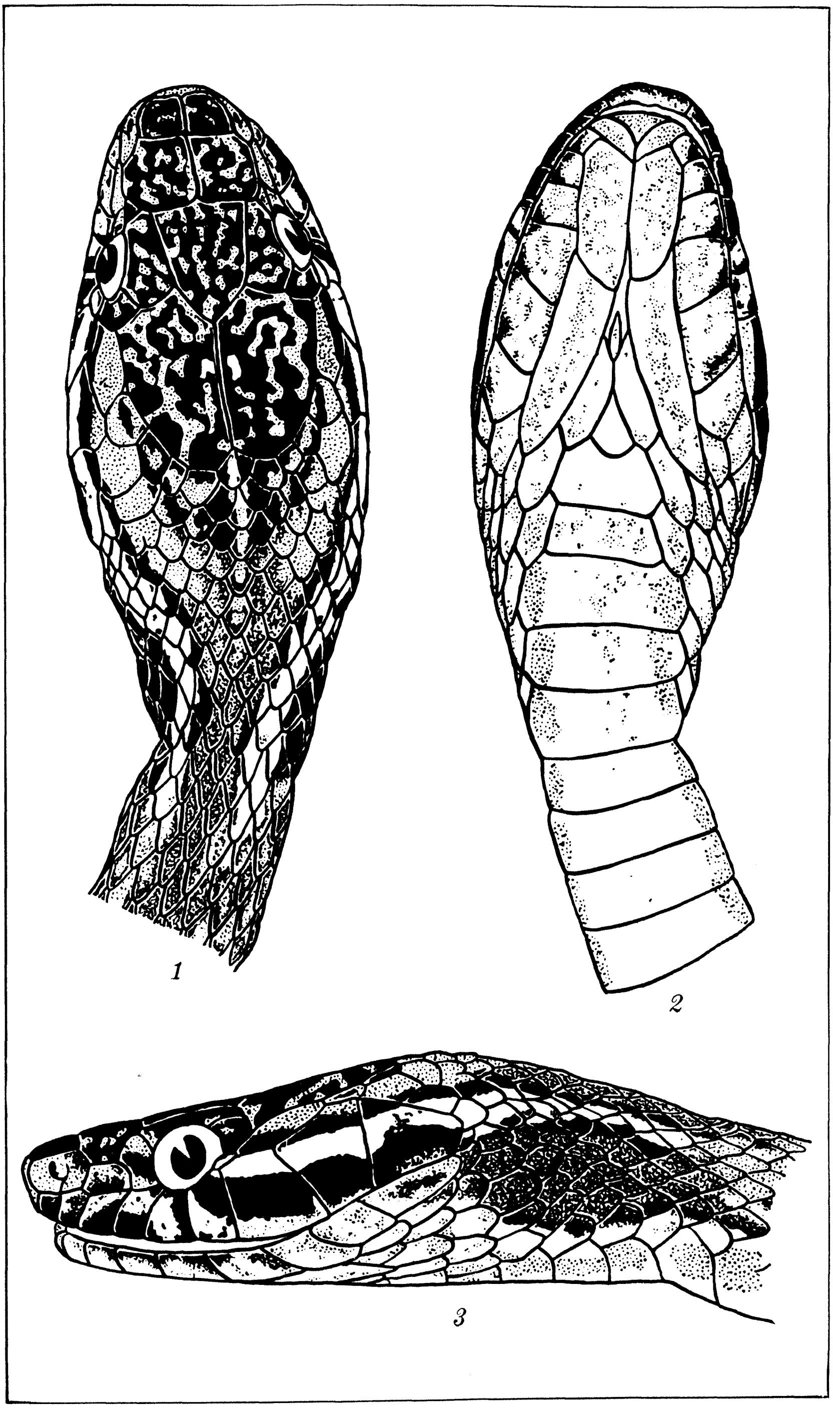

PLATE. 1. NATRIX BOULENGERI GRESSITT.

UNIV. OF MICH.

THE HORNETS OF THE PHILIPPINES

HYMENOPTERA, DIPLOPTERA, VESPINÆ

By J. BEQUAERT
Of the Museum of Comparative Zoology, Harvard University, Cambridge

The hornets of the Indo-Malayan Region belong to two genera, differing as shown in the following key.

Key to the Indo-Malayan genera of hornets.

Head small, outer orbits narrow, vertex short; posterior ocelli placed about as far from occiput as from eyes. Ocelli very large, close together. First abdominal segment cup-shaped, tergite convex and broadly rounded off anteriorly .... *Provespa.*

Head very large, outer orbits broad, vertex long; posterior ocelli placed at least three times as far from occipital margin as from eyes. Ocelli normal, exceptionally somewhat swollen. First abdominal segment transverse, tergite truncate and abruptly sloping anteriorly.... *Vespa.*

Provespa Ashmead includes three species of nocturnal habits and is known definitely from Sikkim, Bhutan, Burma, Tenasserim, Malacca, Siam, Cambodia, Cochin-China, Sumatra, and Borneo. The occurrence in Celebes is doubtful and, according to J. van der Vecht,[1] this genus does not exist in Java. Ashmead included *Provespa anomala* (de Saussure) (Syn.: *doryloides* de Saussure) in his lists of the Hymenoptera of the Philippines,[2] but there is no evidence that this hornet was ever taken there. There is no specimen from the Islands in any of the collections I have studied. As these nocturnal wasps are attracted by artificial light, they could scarcely be overlooked.

Genus VESPA Linnæus

The hornets of the Philippines belong to three structural species, separable by the following key.

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[1] Entom. Meded. Nederl.-Indië 1 (1935) 41.

[2] Journ. New York Ent. Soc. 12 (1904) 7; Proc. U. S. Nat. Mus. 28 (1904) 151.

Key to the Philippine species of Vespa.

1. Lower margin of eye far from base of mandible; intervening oculomalar space about length of fifth antennal segment in female and worker, about half length of fourth antennal segment in male. Clypeus of female and worker with a deep arcuate excision at apex and prominent, bluntly triangular edges .... *V. tropica.*

Lower margin of eye much nearer base of mandible; intervening oculomalar space at most half length of sixth antennal segment in female and worker, at most half length of seventh antennal segment in male. Clypeus of female and worker arcuately excised at apex, but edges very broad and evenly rounded off.. 2.

2. Clypeus coarsely punctate all over in both sexes. Eyes about as far apart at vertex as at clypeus. Ocelli of normal size, posterior pair smaller than their interval .... *V. affinis.*

Clypeus more superficially and sparsely punctate in both sexes. Eyes somewhat farther apart at clypeus than at vertex. Ocelli somewhat swollen, posterior pair slightly larger than their interval. *V. luctuosa.*

Two of these species are represented in the Philippines by more than one color form, there being nine such forms (or races) of hornets in the Archipelago. For easy identification it may be more practical to compare them in one general key.

Key to the Philippine subspecies of Vespa.

1. Thorax and abdomen wholly or almost wholly black; postscutellum black; at most a narrow pale line at apex of second, more rarely at apex of first and second tergites; head black .... 2.

Head, thorax, and abdomen not wholly nor almost wholly black; abdomen partly orange-yellow, or several of the tergites with pale apical bands, or postscutellum with pale marking, or head partly pale .... 3.

2. Wings uniformly yellowish-russet, only slightly darker close to costa. *V. tropica* var. *deusta.*

Wings very strongly infuscate (almost black) in basal half; apical portion yellowish russet........................ *V. tropica* var. *anthracina.*

3. One or more of first three abdominal tergites extensively orange-yellow or ferruginous. Head and thorax black or with some ferruginous blotches .... 4.

Abdomen without orange-yellow or ferruginous; usually some of tergites margined with pale or dark yellow. Head partly yellowish. Postscutellum partly or mostly yellowish .... 6.

4. First three abdominal tergites with very broad orange-yellow apical margins (rarely fourth also with apical fascia); sternites almost wholly black .... *V. tropica* var. *philippinensis.*

Second or first and second abdominal tergites mostly orange-yellow.... 5.

5. First and second abdominal tergites mostly orange-yellow. Structural characters of *V. affinis* .... *V. affinis* var. *indosinensis.*

Only second tergite and sternite mostly orange-yellow; first tergite rarely with small orange apical spots or narrow margin. Structural characters of *V. tropica* .... *V. tropica* var. *tropica.*

6. Thorax black, except for partly or wholly yellowish postscutellum and sometimes a narrow margin on pronotum. Apical yellowish margins of tergites narrow and regular .... 7.

Thorax more extensively yellowish; in addition to postscutellum, propodeum also marked with yellowish. Apical yellowish margins of tergites wider and more or less notched anteriorly .... 8.

7. Sixth abdominal tergite black.............................. *V. luctuosa* var. *luctuosa.*

Sixth abdominal tergite mostly or wholly yellowish. *V. luctuosa* var. *semperi.*

8. Thorax moderately marked with yellow; scutellum as a rule wholly black. All tergites margined with yellowish, sixth tergite either partly or wholly yellowish .... *V. luctuosa* var. *bellicosa.*

Thorax extensively marked with yellowish; scutellum spotted with yellowish. Only first four tergites of abdomen broadly margined with yellowish, remainder black or fifth tergite narrowly margined .... *V. luctuosa* var. *luzonensis.*

VESPA TROPICA (Linnæus).

I have recently discussed the characters and color forms of this widely distributed Oriental hornet, which has often been confused with *V. affinis.*[3] Of the twelve color forms that I recognize four occur in the Islands, but one of these has been found only in the Sulu Archipelago.

VESPA TROPICA var. TROPICA Bequaert.

Sphex tropica LINNÆUS, Syst. Nat. 10th ed. 1 (1758) 571, "in Indiis."
Vespa tropica var. *tropica* BEQUAERT, Treubia pt. 4 15 (1936) 337.
Vespa cincta FABRICIUS, Syst. Entom. (1775) 362, Malabar.

I have seen two specimens of the typical form from the Sulu Islands; Bud Dajo, Jolo, 1; and Bongao (Tawitawi), 1. It is unknown at present from the rest of the Philippines.

The typical form is common in Tenasserim, Assam, Sikkim, Tonkin, Indo-China, Siam, Penang, Sumatra, Nias, Banka, Billiton, Java, Lombok, Madoera, Amboina, and Borneo.

VESPA TROPICA var. DEUSTA Lepeletier.

Vespa deusta LEPELETIER, Hist. Nat. Ins. Hym. 1 (1836) 506, female, no locality; DE SAUSSURE, Et. Fam. Vesp. 2 (1854) 149, female; SMITH, Cat. Hym. Brit. Mus. 5 (1857) 121; DALLA TORRE, Cat. Hym. 9 (1894) 145; Gen. Insect. Vesp. (1904) 65; ASHMEAD, Journ. New York Ent. Soc. 12 (1904) 7, Bacoor; Proc. U. S. Nat. Mus. 28 (1904) 151; DU BUYSSON, Ann. Soc. Ent. France pt. 3 73 (1904) 489, 528, 2 females, Mindanao, Luzon (Albay, Manila,

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[3] Treubia pt. 4 15 (1936) 333–345.

Mount Arayat), Palawan (Puerto Princesa); WILLIAMS, Expt. Sta. Hawaiian Sugar Planters' Assoc. Ent. Ser. Bull. 14 (1919) 165, fig. 95, female, Los Baños, Luzon; Philip. Journ. Sci. 35 (1928) 78.

Vespa tropica var. *deusta* BEQUAERT, Treubia pt. 4 15 (1936) 341, 2 females and 1 male.

Vespa unicolor SMITH, Journ. Proc. Linn. Soc. London Zool. 7 (1863) 44, female, Buru.

Specimens examined.—LUZON, Manila, (*R. C. McGregor*): Laguna Province, Los Baños (*Coll. Agric.; Philip. Bur. Sci.*); Mount Maquiling, up to 1,000 meters (*Coll. Agric.*); Mount Banahao (*Philip. Bur. Sci.*): Tayabas Province, Atimonan (*Philip. Bur. Sci.*): Camarines Sur Province, Mount Isarog (*M. B. Mariano; Philip. Bur. Sci.*): Nueva Vizcaya Province, Bayombong (*Coll. Agric.*): La Union Province, San Juan (*J. Fontanilla; Coll. Agric.*): Rizal Province, Novaliches (*W. Schultze; Philip. Bur. Sci.*). MINDORO, Calapan (*P. de Mesa*); Mount Halcon (*E. D. Merrill; Philip. Bur. Sci.*); Puerto Galera (*S. M. Cendaña; Coll. Agric.*); Lubang (*P. de Mesa*).

Also known from Celebes, Buru, and Dutch New Guinea. The supposed occurrence in Sumatra is doubtful.

Some of the records from the Philippines in the literature listed above (particularly du Buysson's record Mindanao) are probably based on a specimen of var. *anthracina*, which was until recently confused with var. *deusta*.

VESPA TROPICA var. ANTHRACINA Bequaert.

Vespa tropica var. *anthracina* BEQUAERT, Treubia pt. 4 15 (1936) 341, 2 females and 1 male; type locality, Sibuyan.

Specimens examined.—Sibuyan (*C. F. Baker*). PALAWAN (or Paragua) (*Doherty*); Puerto Princesa (*R. C. McGregor; Philip. Bur. Sci.*); Iwahig (*Philip. Bur. Sci.*); Bacuit (*Prince Leopold of Belgium*). PANAY, Colasi (*R. C. McGregor*). MINDANAO, Surigao Province, Surigao (*C. F. Baker*): Davao Province, Calian (*C. F. Clagg*): Zamboanga Province, Dapitan. Not located: Bukidnon Province (*Philip. Bur. Sci.*).

From available records it would appear that, while var. *deusta* is common in the northern half of the Archipelago (Luzon, Mindoro, Lubang), it is replaced by var. *anthracina* in the southern half (Sibuyan, Panay, Palawan, Cebu, Mindanao). The latter form is not known outside the Philippines.

VESPA TROPICA var. PHILIPPINENSIS de Saussure.

Vespa philippinensis DE SAUSSURE, Et. Fam. Vesp. 2 (1854) 148, male, Philippines; SMITH, Cat. Hym. Brit. Mus. 5 (1857) 121; Journ. Proc. Linn. Soc. London Zool. 5 (1860) 131; 7 (1863) 44; DALLA TORRE, Cat. Hym. 9 (1894) 152; Gen. Insect. Vesp. (1904) 65; ASHMEAD, Journ. New York Ent. Soc. 12 (1904) 7, Baliwag; Proc. U. S. Nat. Mus. 28 (1904) 151; DU BUYSSON, Ann. Soc. Ent. France pt. 3 73 (1904) 489, 529, female, Mindanao.

Vespa tropica var. *philippinensis* BEQUAERT, Treubia pt. 4 15 (1936) 342, 2 females and 1 male.

Specimens Examined.—Luzon, Laguna Province, Los Baños (*C. P. Dolores; Philip. Bur. Sci.*). SAMAR, Mauo River (*Prince Leopold of Belgium*); Oquendo (*Philip. Bur. Sci.*). NEGROS, Occidental Negros Province, Maao (*C. S. Banks; Philip. Bur. Sci.*); Canlawan (*C. S. Banks; Philip. Bur. Sci.*). MINDANAO, Surigao Province, Surigao (*C. F. Baker*). Not located, Ubay (*Semper*).

F. Smith's records of this form from Buru and Amboina need confirmation.

VESPA AFFINIS (Linnæus).

This species, often confused with *V. tropica* (*V. cincta* of authors), was also revised in Treubia.[4] I recognized six color forms, only one of which is known from the Philippines.

VESPA AFFINIS var. INDOSINENSIS (Pérez).

Vespa unifasciata OLIVIER, Encyclop. Méthod. Insectes 6 (1791) 677, "Indes orientales;" not *V. unifasciata* Gmelin, 1790.

Vespa nigripennis DE SAUSSURE, Et. Fam. Vesp. 2 (1854) 156, female, Philippines; SMITH, Cat. Hym. Brit. Mus. 5 (1857) 121; DALLA TORRE, Cat. Hym. 9 (1894) 150; Gen. Insect. Vesp. (1904) 65; ASHMEAD, Journ. New York Ent. Soc. 12 (1904) 7; Proc. U. S. Nat. Mus. 28 (1904) 151; DU BUYSSON, Ann. Soc. Ent. France pt. 4 73 (1904) 620; not *V. nigripennis* de Geer (1773).

Vespa indosinensis PÉREZ, Actes Soc. Linn. Bordeaux 64 (1910) 8, (1910) 8, male or female, Cochin-China, Annam, Malacca, northern Celebes; India.

Vespa affinis var. *indosinensis* BEQUAERT, Treubia pt. 4 15 (1936) 349, 2 females and 1 male.

Specimens examined.—Samar, Mauo River (*Prince Leopold of Belgium*). PALAWAN (or Paragua), Biscuit (*Prince Leopold of Belgium*); Puerto Princesa (*R. C. McGregor; Philip. Bur. Sci.*); Iwahig (*C. M. Weber; Philip. Bur. Sci.*). DUMARAN (*W. Schultze; Philip. Bur. Sci.*). MINDANAO, Zamboanga Province, Zamboanga.

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[4] pt. 4 15 (1936) 345–351.

The specimens from the Philippines (Luzon, Puerto Princesa) recorded by R. du Buysson under *V. cincta* var. *affinis* [5] were var. *indosinensis*. Ashmead includes *V. cincta* in one of his lists of Philippine Hymenoptera [6] but apparently he saw no specimens. The var. *indosinensis* is widely distributed, being known also from Indo-China, the Federated Malay States, Sumatra, Simalur, Engano, Nias, Banka, Mentawei Archipelago, Borneo, Celebes, Ternate, Halmahera, Amboina, Salawatti, Aru, Waigeu, and New Guinea.

VESPA LUCTUOSA de Saussure.

In a recent paper [7] I recognized five color forms of this species, four of them known from the Philippines. The fifth form, *V. luctuosa* var. *malayana* Bequaert (= *V. annulata* Smith), occurs in Borneo and Sumatra.

VESPA LUCTUOSA var. LUCTUOSA (de Saussure).

> *Vespa luctuosa* DE SAUSSURE, Et. Fam. Vesp. 2 (1854) 143, 1 male, Philippines; SMITH, Cat. Hym. Brit. Mus. 5 (1857) 121; DALLA TORRE, Cat. Hym. 9 (1894) 148; Gen. Insect. Vesp. (1904) 65; ASHMEAD, Journ. New York Ent. Soc. 12 (1904) 7, Bacoor; Proc. U. S. Nat. Mus. 28 (1904) 151; DU BUYSSON, Ann. Soc. Ent. France pt. 4 73 (1904) 619, 1 male; WILLIAMS, Expt. Sta. Hawaiian Sugar Planters' Assoc. Ent. Ser. Bull. 14 (1919) 164, Los Baños; Philip. Journ. Sci. 35 (1928) 78; BEQUAERT, Bull. Mus. R. Hist. Nat. Belgique (28) 10 (1934) 3, 2 females and 1 male.

Specimens examined.—LUZON, Laguna Province, Mount Maquiling (*C. F. Baker*); Mount Banahao (*C. F. Baker*); Los Baños (*Philip. Agric.*); Majayjay (*C. S. Banks; Philip. Bur. Sci.*): Rizal Province, Mount Pulo (*R. C. McGregor*): Tayabas Province, Gumaca (*Foxworthy; Philip. Bur. Sci.*); Kasiguran (*A. Duyag; Philip. Bur. Sci.*). MINDORO, Mount Halcon (*E. D. Merrill; Philip. Bur. Sci.*); Calapan (*P. de Mesa*). MINDANAO, Cotabato Province, Kolambugan (*C. S. Banks; Philip. Bur. Sci.*); Jalog River, Mount Apo, 6,000 feet (*C. F. Clagg*): Davao Province, Calian (*C. F. Clagg*). NEGROS, Oriental Negros Province, Dumaguete (*J. W. Chapman*): Occidental Negros Province, Maao (*C. S. Banks; Philip. Bur. Sci.*). TICAO (*R. C. McGregor; Philip. Bur. Sci.*). SAMAR, Oquendo (*Philip. Bur. Sci.*).

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[5] Ann. Soc. Ent. France pt. 3 73 (1904) 536.

[6] Proc. U. S. Nat. Mus. 28 (1904) 151.

[7] Bull. Mus. R. Hist. Nat. Belgique (28) 10 (1934) 1–50.

Apparently distributed over the entire Archipelago and common everywhere, but not known outside the Philippines. The queens are much larger than the workers and much less marked with pale yellow (more ivory-white) on the abdomen; this wasp is sometimes entirely black or the first tergite only is narrowly margined. Often also there is only a narrow transverse pale-yellowish streak on the postscutellum.

VESPA LUCTUOSA var. SEMPERI du Buysson.

Vespa bellicosa var. *semperi* DU BUYSSON, Ann. Soc. Ent. France pt. 3 73 (1904) 542, 1 female, Comigu, Mindanao, Lubang, Luzon, Tayabas.

Vespa luctuosa var. *semperi* BEQUAERT, Bull. Mus. R. Hist. Nat. Belgique (28) 10 (1934) 4, female.

Specimens examined.—MINDANAO, Davao Province, Calian, (*C. S. Clagg*): Cotabato Province, Kolambugan (*C. S. Banks; Philip. Bur. Sci.*): Zamboanga Province, Zamboanga.

Var. *semperi* is not known outside the Philippines and seems to occur sporadically with typical *luctuosa.*

VESPA LUCTUOSA var. BELLICOSA de Saussure.

Vespa bellicosa DE SAUSSURE, Et. Fam. Vesp. 2 (1854) 146, pl. 14, fig. 10, 1 female, Java; DU BUYSSON, Ann. Soc. Ent. France pt. 3 73 (1904) 488, 489, 540, pl. 5, fig. 7, 2 females and 1 male.

Vespa luctuosa var. *luzonensis* BEQUAERT, Bull. Mus. R. Hist. Nat. Belgique (28) 10 (1934) 4, 1 female.

Specimen examined.—MINDANAO, Surigao Province (C. F. *Baker*). The specimen from Zamboanga, which I listed under *bellicosa* in 1934, was of the var. *semperi.*

Although very rare in the Philippines, this form is common in Borneo, Sumatra, and the Moluccas. It is also reported from Singapore.

VESPA LUCTUOSA var. LUZONENSIS Bequaert.

Vespa luctuosa var. *luzonensis* BEQUAERT, Bull. Mus. R. Hist. Nat. Belgique (28) 10 (1934) 5, 1 female, Luzon.

Specimens examined.—Luzon, holotype, 1 female, without definite locality (Berlin Mus.). Also several paratypes at the Berlin Museum, labelled "Philippines."

So far as known, this form is peculiar to the Archipelago.

THE TREATMENT OF SCHISTOSOMIASIS JAPONICA WITH FUADIN[1]

By **MARCOS A. TUBANGUI** and **PANTALEON J. AGUILA**
Of the Bureau of Science, Manila

Fuadin (also written as "fouadin")[2] has been employed extensively in Egypt by Khalil and his co-workers (2, 4, 5) along with tartar emetic for the control of schistosomiasis hæmatobia and schistosomiasis mansoni. Both drugs have been found to be effective, but fuadin is preferred because it is less toxic and can be injected intramuscularly without producing much pain. According to the literature, fuadin has not yet been extensively tried against schistosomiasis japonica, which is considered to be more dangerous and more fatal than either of the two Egyptian types of parasitism. For this reason and in view of the fact that we have been interested in finding a safe but reliable therapeutic agent for the control of Oriental schistosomiasis in the Philippines, we decided to test the drug on some cases of the disease which we encountered during an epidemiological survey in Mindoro Island during October, 1939.

DOSAGE AND METHOD OF ADMINISTRATION

The standard dose of 40 cc of fuadin recommended by Khalil and Betache (4) was given to each adult individual weighing approximately 60 kilograms. This dose was divided into nine injections and administered intramuscularly into the buttocks, alternately on both sides. The first dose was 1.5 cc of the solution, the second 3.5 cc and the rest 5 cc each. The first three injections were given at daily intervals, the rest at intervals of two days. The dosage for children and emaciated persons was reduced proportionately according to their weights.

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[1] Aided by a grant from the National Research Council of the Philippines.

[2] The drug is labelled as a "brand of sodium antimony biscatechol disulphonate of sodium, the descriptive name of which is Stibophen." It is prepared as a clear, isotonic solution, each cc containing 0.063 gram of fuadin (= 8.5 milligrams of trivalent antimony).

We are very gratefully indebted to Mr. U. von Prittwitz, the manager of the Manila Branch of the Winthrop Chemical Company, Incorporated, for the supply of fuadin used in the treatment of the schistosomiasis japonica cases recorded in this paper.

UNTOWARD EFFECTS OF THE DRUG

The majority of the cases treated lived quite far from our improvised laboratory in Sitio Borbocolon, Naujan, Mindoro, where the injections were given. They had, therefore, to walk several kilometers before and after receiving an injection. Except in the case of two male individuals who were weak and emaciated, the patients were allowed to continue with their regular occupations during the course of the treatment. Our object was to find out if the drug can be safely administered under such conditions and in places far removed from hospitals. To our knowledge not a single patient suffered sufficiently from any toxic effect of the drug to need special attention. The only inconveniences experienced were slight headache, transient rheumatic pains accompanied with fever, and in a few cases nausea and vomiting. These symptoms usually appeared following the first or second injection. After the sixth or seventh injection some of the patients began to feel the beneficial effect of the treatment.

RESULTS OF THE TREATMENT

A total of 34 cases received injections of fuadin, but only 19 completed the treatment. Of the latter, as shown in Table 1, 10, 52.6 per cent, were apparently cured. The success of the treatment was based on failure to find schistosome eggs by repeated examination of the fæces after the last fuadin injection. In several cases a marked improvement in the physical condition of the patient was very noticeable if the treatment was successful. In some individuals the lethal effect of fuadin on the schistosome parasite was not noted until several days after the administration of the last injection. In a few instances, however, the ova of the parasite disappeared as early as after the eighth injection or, if present, they were few in number and contained dead miracidia. One female patient became negative by fæcal examination for seven days after the last injection, but was again positive when examined two weeks later. This was probably a case of relapse.

TABLE 1. *Results of a complete course of treatment with fuadin on 19 individuals affected with schistosomiasis japonica.*

Patient.	Age.	Sex.	Result of fæcal examination. [a]			
			After 8th injection.	One day after 9th injection.	Seven days after 9th injection.	Twenty days after 9th injection.
G. A.	58	male	+	+	—	—
L. O.	56	do	+	±	—	—
J. V.	38	do	±	±	—	—
C. V.	16	female	+	+	+	+
M. M.	39	male	+	+	+	+
J. G.	12	do	+	+	+	+
N. R.	30	do	+	+	+	+
S. O.	14	do	+	+	+	+
S. G.	19	do	+	—	—	—
C. M.	42	do	+	+	+	+
F. V.	20	female	+	—	—	+
P. M.	13	male	—	—	—	—
E. E.	25	do	+	+	+	+
B. J.	28	do	±	—	—	—
F. V.	19	do	+	+	—	—
G. I.	14	do	+	+	—	—
R. A.	22	do	+	+	+	+
T. A.	26	female	+	—	—	—
P. C.	17	do	+	+	—	—

[a] +, positive for schistosome eggs; —, negative for schistosome eggs; ±, eggs with dead miracidia.

DISCUSSION

The results of our treatment compare favorably with those obtained at the Research Insitute of the Public Health Department of Egypt for the year 1934, as mentioned by Khalil.(3) In China, however, Kan and Yao(1) obtained a higher percentage of cures; namely, 68 per cent, against our 52.6 per cent. A question bound to be asked is why, if the drug is effective, a larger number of cases are not cured. There are two possible answers to this question, and one of them has to do with the fact that very advanced cases of schistosomiasis japonica, where the function of the liver is much impaired due to extensive cirrhotic changes, are probably beyond the capacity of any drug to cure. In our series there were two such cases, and they were among those who derived no apparent benefit from the treatment. The other reason may have something to do with the recent observations of Khalil,(3) who noted that the rapidity and degree of excretion of antimony from the body vary in different individuals, and that this variation may influence the therapeutic efficiency of the drug. There are persons who excrete the drug so rapidly that they need to be given repeated courses of the treatment before they can be cured. On the other hand, there are individuals who eliminate the drug very slowly and, if given the usual doses, are liable to suffer from its toxic effects and may even die. Between the two extremes are those persons who eliminate the drug at an average rate and for whom the standard course of treatment is sufficient to bring about a cure. In order, therefore, to obtain better and more uniform results and to guard against accidents that may be brought about by the toxic effect of fuadin, Khalil suggests that the dose be calculated, not according to age and weight, but according to the amount of the drug that can be retained in the body for a reasonable length of time. For this purpose he recommends the so-called "Fouadin test", by means of which the rate of excretion of the drug in the urine may be estimated at different intervals after the first injection. In the treatment of our cases, however, we were not able to perform this test due to lack of time and facilities.

SUMMARY AND CONCLUSIONS

1. A total of 19 cases of schistosomiasis japonica were given a complete course of treatment with fuadin. Of that number, 10, 52.6 per cent, were apparently cured. Of the 9 persons who were not cured, 1 had a relapse and 2 were very advanced cases.
2. As claimed by previous workers, the drug appears to be of value in the treatment of the disease. The suggestion of Khalil that the dose be calculated, not according to the age and weight of the patient, but according to his ability to retain the drug in the body during a reasonable length of time, should be given a trial in order to see whether by so doing the percentage of cures can be increased.

LITERATURE CITED

1. KAN, H. C., and Y. T. YAO. Some notes on the antischistosomiasis japonica campaign in Chih-Huai-fan, Kaihua, Chekiang. Chinese Med. Journ. 48 (1934) 323-336.
2. KHALIL, M. The specific treatment of human schistosomiasis (bilharziasis) with special reference to its application on a large scale. Arch. f. Schiffs-u. Tropen-Hyg. (Beihft. 2) 35 (1931) 1-128.

3. KHALIL, M. Individual variation in the excretion of drugs as an important factor in their therapeutic results. A practical method for detecting the schistosomiasis cases with so-called idiosyncrasy to antimony to avoid fatalities and complication. Journ. Egypt. Med. Assoc. **19** (1936) 285–305.
4. KHALIL, M., and M. H. BETACHE. Treatment of bilharziasis with a new compound "Fouadin." Report on 2041 cases. Lancet **1** (February 1, 1930) 234, 235.
5. KHALIL, M., M. NAZMI, F. M. PETER, M. SALAH EL DIN, and M. H. BETACHE. Die Behandlung der Schistosomiasis mit intramuskularen "Fuadin"-Injektionen. Deutsche med. Wochenschr. **55** (1929) 1125, 1126.

SODA PROCESS FOR PULPING CANTON FIBER

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Canton (*Musa* sp.) resembles Manila hemp (*Musa textilis*) so closely that the fibers of the two are often difficult to distinguish.[1] Canton is one of the sturdiest of the Musaceæ. It stands adverse weather better than Manila hemp. For this reason it is commonly grown in hemp (abaca) plantations as shade[2] for abaca. Locally it is believed that this plant improves the soil and tends to prevent the effects of drought on abaca.

Measurements in length and diameter show that Canton compares favorably with other fibers of good quality. In view of these characteristics and the fact that canton grows easily, a further investigation was made of this plant. Accordingly, experiments on the manufacture of pulp and paper from Canton fiber were carried out. The results, showing that good wrapping paper can be made from this fiber, are given in this report.

Canton is found in the Bicol region, and covers extensive areas in Albay Province and on Catanduanes and Cagraray Islands.

On account of its poor keeping quality and relatively lower tensile strength than hemp, stripped Canton fiber has no special use at present except for local cordage making. In many plantations, however, growers strip the fiber and mix it indiscriminately with Manila hemp. Since the quality of hemp adulterated with canton is reduced, this practice is rather serious, especially in the absence of practical methods to ascertain readily the presence of Canton in a bale of abaca or commercial fiber.

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[1] Manuel, C. Methods for disinguishing Canton fiber from abaca. Progressive Farming (4) 1 (1937) 123.

Sherman, H. E. Some chemical differences between abaca and canton fibers. Philip. Journ. Agr. 1 (1930) 123.

[2] Rivera, Jose Jr. Partial Survey of Camarines Sur, Albay, and Sorsogon Provinces Regarding Canton, Amokid, Pacol and Other Fiber-Producing Plants. Report of the Traveling Fiber Inspector. Philip. Bur. Agr. (1931).

Sherman[3] investigated Canton and reported that this fiber, compared with abaca of the same stripping, shows a lower tensile strength and percentage of elasticity but a higher acidity and percentage of ash.

Measurements of Canton fibers, made in this laboratory, are given in Table 1, which also includes the measurements of other fibers as reported by Fischer and Brown.[4]

TABLE 1.—*Dimensions of Canton and some other fibers.*

Sample.	Length.			Diameter.		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Canton (*Musa* sp.)	6.80	2.63	4.02	0.022	0.011	0.0160
Abaca (*Musa textilis*)	6.00	3.98	2.45	0.021		0.0170
Plantain (*Musa sapientum* var. *paradisiaca*)	7.30	5.49	4.15	0.026	0.018	0.0200
Maguey (*Agave cantula*)	4.93	2.38	1.00	0.026	0.005	0.0180
Cogon grass (*Imperata exaltata*)	1.82	0.99	0.46	0.021	0.005	0.0110
Talahib grass (*Saccharum spontaneum*)	2.82	1.59	0.80	0.020	0.012	0.0150
Bamboo (*Bambusa blumeana*)		1.81				0.0075
Dwarf bamboo (*Bambusa lumampao*)	4.10	2.57	1.20	0.028	0.005	0.0156
Rice straw (*Oryza sativa*)		0.88				0.0025
Buri palm (*Corypha elata*)	2.80	2.11	1.10	0.015	0.010	0.0130

As shown in Table 1, the measurements of Canton compare favorably with those of abaca and other fibers.

MATERIAL

The material used for this investigation consisted of eight full-grown stalks obtained from Albay Province through the courtesy of the Director of Plant Industry. These green stalks were 16 months old and about 6.5 feet long. They consisted principally of water, which amounted to 95 per cent of the total weight.

The sheaths of each stalk were separated, split into strips about ½ inch wide, and dried in the sun for three weeks. For the estimation of the various chemical constants of the plant about two pounds of the air-dried sheaths were shredded and screened to render the sample as uniform in size as possible. The portion passing a 40-mesh screen and retained on a 60-mesh screen was used for the analysis. For digestion the air-dried sheaths were cut into ½ inch lengths so they could be conveniently charged into the autoclave.

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[3] Sherman, H. E. Some chemical differences between abaca and canton fibers. Philip. Journ. Agr. 1 (1930) 123.

[4] Brown, W. H. Minor Products of Philippine Forests. 1. Bureau of Printing, Manila (1920) 415.

EXPERIMENTAL PROCEDURE

Analysis.—With the exception of the lignin determination the analytical methods adopted by the Technical Association of the Pulp and Paper Industry[5] were followed.

It was observed that the residue of a sample digested with 72 per cent sulphuric acid for 16 hours was difficult to filter through an alundum crucible (RA—98). By increasing the length of time for hydrolysis from 16 to 24 hours, however, the lignin was satisfactorily filtered, indicating that the cellulose or nonlignous bodies in canton are more resistant to the action of the acid hydrolysis than materials ordinarily used in the cellulose industry. The analysis of the dried stalk of the Canton plant is recorded in Table 2.

TABLE 2.—*Analysis of the stalk of the Canton plant.*

Constituents.	Per cent.
Extractives:	
Alcohol-benzene	7.71
Alkali (1 per cent NaOH)	35.82
Cold water	13.18
Hot water	1.34
Pentosans	14.55
Lignin	22.86
Ash	5.21
Total cellulose	50.04
Ash in cellulose	0.42
Ash-free cellulose	49.62
Alpha cellulose in stalk	43.63

The total cellulose content of Canton is somewhat lower than that of wood ordinarily used in paper making. The alpha cellulose content is also low, indicating that the pulp is made of components soluble in 17.5 per cent alkaline solution.

Canton stalk contained an unusually high percentage of extractives and pentosans.

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[5] Technical Association of the Pulp and Paper Industry. New York (September 15, 1936).

Digestion.—The digestion of the dried Canton stalk was made by means of the soda process in an autoclave of 5-liter capacity. The results are shown in Table 3.

TABLE 3.—*Digestion of Canton stalk by the soda process.*

Sample.	Sodium hydroxide.				Time of digestion.	Temperature.	Pulp yield.
	Concentration.		Amount used.				
	Grams per liter.	*Per cent.*	*Liters.*	*Grams.*	*Hrs.*	°C.	*Per cent.*
1	59.33	5.93	1.5	89.0	5.0	160	28.5
2	47.46	4.75	1.5	71.2	5.0	160	29.9
3	35.60	3.63	1.5	53.4	5.0	160	32.1
4	27.60	2.76	2.0	55.2	8.0	160	33.4
5	27.60	2.76	2.0	55.2	8.0	155	32.9
6	26.70	2.67	2.0	53.4	7.5	160	32.8

[a] Three hundred fifty-six grams of oven-dried material was used for each sample.

Three digestions (samples 1, 2, and 3) were made to study the effect of the concentration of chemicals on the yield and quality of the pulp, and three digestions (samples 4, 5, and 6) were made to determine the effect of temperature. Concentration, chemicals, and pulp yield were calculated on the basis of the oven-dry weight of the raw material. The heat was gradually raised from room temperature to the maximum limit employed for each sample and maintained constant at that point until the end of the digestion. The maximum limits for the various samples ranged from 155 to 160°C. The time indicated in Table 3 includes an hour that was allowed for the heat to reach the maximum temperature.

Effect of alkali concentration and temperature on pulp yield.—Compared with the total cellulose in Table 2, the pulp yield on digestion (Table 3) is relatively low, indicating that a good deal of the available fiber in Canton dissolves readily in alkaline pulping solution at elevated temperatures. In digesting the material with a liquor concentration of 59.33 grams per liter the pulp yield is low, amounting to 28.5 per cent based on the oven-dry weight of the stalk. A decrease in the alkali concentration from 59.33 to 27.6 grams per liter gives a corresponding increase in the pulp yield from 28.5 to 33.4 per cent. It appears, therefore, that a decrease in concentration of 1 gram per liter gives an increase in pulp yield of approximately 0.15 per cent.

Slight variations in temperature at the digestion range had little effect on the pulp yield. The trivial difference in pulp yield of samples 4, 5, and 6 (Table 3) is an indication that a 5° change in the cooking temperature (155 to 160° C.) is insufficient to affect the results of digestion to any appreciable extent.

The physical properties of the pulp.—After digesting the canton stalks, 50 grams of the resulting pulp, calculated on an oven-dry basis, was hollandered (beaten) for about a half hour and then made into test sheets. These sheets were prepared in accordance with the official methods of the Forest Products Laboratory at Madison, Wisconsin. They were tested for weight, thickness, and bursting strength. The results are given in Table 4.

TABLE 4.—*Properties of test sheets prepared from Canton pulp hollandered for a half hour.*

Sample.	Concentration of cooking solution.	Ream weight (25×40 inch, 500).	Thickness.	Bursting strength, lbs. per sq. in.	Bursting ratio.
	Grams per liter.	*lbs.*	*inch.*	*pts.*	*pts. per lb. per ream.*
1	59.33	45.5	0.0042	61	1.34
2	47.46	53.7	0.0046	76	1.43
3	35.60	39.9	0.0038	60	1.51
4	27.60	49.6	0.0043	80	1.62
5	27.60	45.5	0.0041	82	1.65
6	26.70	43.3	0.0041	77	1.70

The matting quality of the unbeaten pulp is poor, but with a 30-minute beating it can be formed into sheets without difficulty. Samples of the pulp were analyzed for their various constituents, such as cellulose, alpha cellulose, pentosans, and lignin. In addition their bleach requirements were also tested. We found that the pulps obtained from all the digestions were difficult to bleach.

A gradual decrease in the concentration of the cooking solution caused a corresponding increase in the strength of the pulp, provided other factors were maintained constant. The increase in strength (bursting ratio) reached 1.51 points per pound per ream at a liquor concentration of 35.6 grams per liter and a total volume of 1.5 liters. As the concentration of the digesting solution was further decreased to 27.6 grams per liter, with a simultaneous increase in volume to 2 liters, the bursting strength ratio of the pulp increased correspondingly to 1.62 points per pound per ream (Table 4, experiment 4).

From a concentration of 27.6 to 26.7 grams per liter there was an increase from 1.62 to 1.70 pounds per ream in the bursting ratio. This decrease in concentration amounts to 0.9 gram per liter with a corresponding decrease in time of digestion of 8 to 7.5 hours (Table 3).

On the cellulose content of the pulp.—The effect of alkali concentration on the total cellulose and alpha cellulose contents of the pulps is relatively small, a maximum value being obtained when the concentration of the cooking liquor is 27.6 grams per liter (Table 5, experiment 5).

In Table 5 is given the analysis of unbleached Canton pulp. These results compared with those recorded in Tables 3 and 4 show that the total cellulose content and the strength quality of the pulp are not affected to any marked extent by a small variation of the digestion temperature. In the light of this finding it may be inferred that a small variation in range of digesting temperature produces no material effect on the yield and quality of the pulp.

TABLE 5.—*Analysis of unbleached Canton pulp.*

Sample.[a]	Total cellulose.	Alpha cellulose.	Lignin.	Pentosans.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	80.40	67.2	3.20	6.4
2	85.83	69.4	5.62	6.4
3	87.30	68.6	6.43	8.4
5	87.70	70.3	5.97	5.7
6	87.20	69.8	4.27	8.6

[a] These samples were the same as those recorded in Tables 2, 3, and 4.

NOTE.—Pulp from sample 4 was not analyzed.

The data on the strength ratio of test sheets of paper made from unbleached Canton pulp are presented in Table 6. This pulp was beaten about 30 minutes. The results show that this paper is comparable in strength to imported brown or wrapping paper.

TABLE 6.—*Test sheets from Canton pulp compared with a commercial wrapping paper.*

Sample.	Ream weight (25×40-inch, 500).	Thickness.	Bursting strength, lbs. per sq. in.	Bursting ratio.
	lbs.	*inch.*	*pts.*	*pts. per lb. per ream.*
Canton	46.3	0.0042	73	1.54
Commercial	71.9	0.0058	77	1.07

SUMMARY

Canton fiber can be converted into pulp by the soda process. The pulp is suitable for the manufacture of strong unbleached paper.

Soda pulp from Canton fiber requires a large amount of bleach to get the color to a medium degree of whiteness.

Sheaths of Canton, properly cut, are bulky, requiring a relatively large space for digestion.

Concentration of the cooking solution (sodium hydroxide) shows a definite effect on the yield and quality of the pulp. If other factors are maintained constant, the pulp yield generally increases with a decrease in the concentration of the cooking liquor. A maximum of 33.4 per cent based on the oven-dry weight of the raw material being attained when the concentration is 27.6 grams per liter.

A small variation in the cooking temperature from 155 to 160° C. shows no material effect on the yield and quality of the pulp.

PREPARATION AND ANALYSIS OF RUN MANILA COPAL

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THREE TEXT FIGURES

Manila copal resin is obtained from a tree known botanically as *Agathis alba* (Lam.) Foxw. This is a large tree that grows in the Philippines from the extreme north of Luzon to the southernmost islands of this group. The copal resin is contained in the bark of this tree and oozes out whenever the tree is cut. The resin is used principally for making high-grade varnishes.

This paper is a continuation of our work on Philippine resins. In previous reports[1] methods were given for analyzing and refining Manila copal. It was found to consist mostly of resin acids together with some terpenes, resenes, and material insoluble in alcohol.

Soft Manila copal is not soluble in drying oils such as linseed oil. In order to make oil varnishes with this resin it is customary to heat it until volatile constituents, such as water, terpenes, and decomposition products have been removed. This heating process is known in the varnish industry as running.

Recently we had occasion to prepare some samples of run copal. In order to ascertain the difference in the composition of the copal, before and after running, a method was devised for analyzing the run copal. Details of this analytical procedure and results showing the composition of natural and run copal are given in this paper.

Several investigations[2] have indicated that some of the acids in Manila copal are dibasic. When the resin is run (heated) at a temperature of about 300 to 310 ° C., to remove volatile constituents, the dibasic acids are converted to monobasic, thus reducing the acidity of the copal. Continued heating of the copal at a temperature somewhat above 310 ° C. tends to convert the monobasic acids into hydrocarbons as follows:

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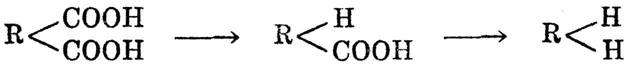
[1] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. **73** (1940) 259–283; G. D. Manalo and A. P. West, ibid. 285–290.

[2] Wolff, H., Farbenztg. **29** (1924) 2039; P. Horrmann and N. Kroll, Arch. Pharm. **265** (1927) 214; L. Ruzicka and J. R. Hosking, Ann. **469** (1929) 147.



$$\mathrm{R}{<}^{\mathrm{COOH}}_{\mathrm{COOH}} \longrightarrow \mathrm{R}{<}^{\mathrm{H}}_{\mathrm{COOH}} \longrightarrow \mathrm{R}{<}^{\mathrm{H}}_{\mathrm{H}}$$

In such a series of thermal transformations in resins there are likely to be side reactions that may yield both volatile and nonvolatile products.

EXPERIMENTAL PROCEDURE

The Manila copal used in this investigation was kindly presented to us by the F. E. Zuellig Company, copal dealers, Manila, and consisted entirely of the soft variety. That is, except for the foreign matter and gelatinous material contained in it, the resin was soluble in alcohol. Average characteristic samples obtained from a definite location were powdered finely and the powder mixed thoroughly to render uniform samples. The copal was analyzed in accordance with a method devised in a previous investigation[3] (text fig. 1).

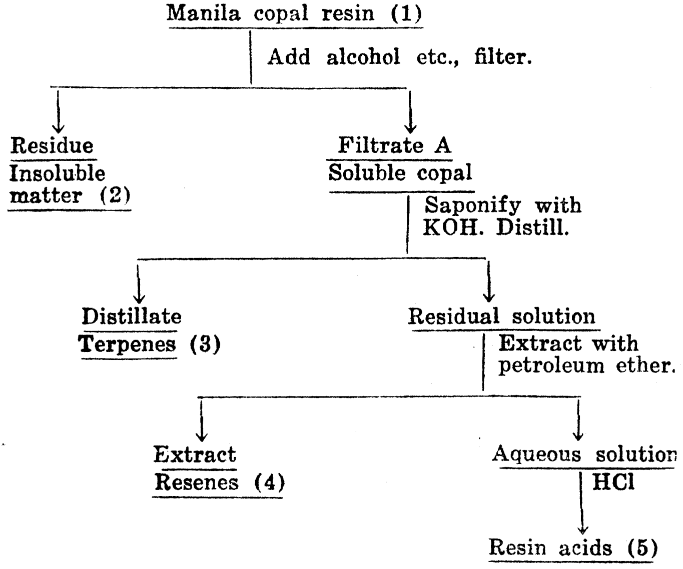


FIG. 1. Analysis of Manila copal.

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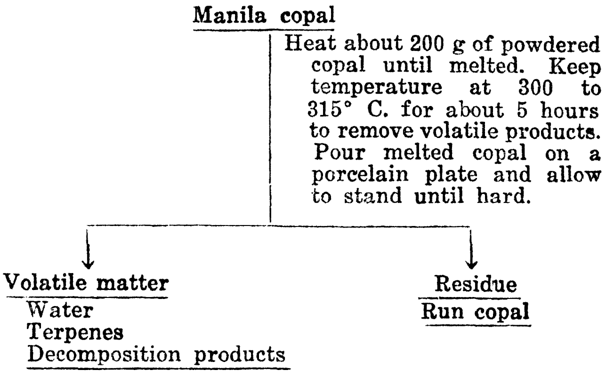
[3] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259–283.

After the composition of the copal was ascertained it was run as indicated in Fig. 2.



Heat about 200 g of powdered copal until melted. Keep temperature at 300 to 315° C. for about 5 hours to remove volatile products. Pour melted copal on a porcelain plate and allow to stand until hard.

FIG. 2. Preparation of run Manila copal.

About 200 grams of the powdered resin were placed in a distilling flask which was then connected to a condenser. The flask was gradually heated over asbestos wire gauze for about 1 to 1.5 hours, depending on the sample, until the frothing subsided and the melt was gently boiling. The heating was then continued at a temperature of about 300 to 315 ° C. for about 4 hours longer to complete the running process. The hot liquid was finally poured on a porcelain plate and allowed to cool. It was then broken into lumps which were placed in a bottle that was stoppered securely and kept in a dark place.

The same procedures were employed to determine the constants of the copal both before and after running.

Acid number.—The acid number is ascertained by treating approximately 1 gram of the powdered copal with 50 cubic centimeters of a mixture consisting of neutral absolute alcohol and benzene (25 cc each) and titrating directly with seminormal alcoholic potassium hydroxide in the presence of phenolphthalein.

Saponification number.—For the determination of the saponification number approximately 1 gram of powdered copal is treated with 50 cubic centimeters of absolute alcohol, and 25 cubic centimeters of seminormal alcoholic potassium hydroxide is added. The mixture is heated on a steam bath with a reflux condenser for 2 hours. The solution is then cooled and the excess alkali titrated with seminormal sulphuric acid in the presence of phenolphthalein.

Ester number.—The ester number is the difference between the saponification and acid numbers.

Data on the constants of Manila copal, before and after running, are given in Table 1.

TABLE 1.—*Constants of Manila copal before and after running.*

The copal was run (heated) at 300 to 315° C. for 5 hours.

Sample.	Constants.					
	Before running.			After running.		
	Saponification No.	Acid No.	Ester No.	Saponification No.	Acid No.	Ester No.
35	188.66	129.04	59.62	97.23	83.55	13.68
36	204.64	123.23	81.41	108.18	92.78	15.40
37	171.56	107.78	63.78	101.80	76.83	24.97
38	197.17	125.53	71.64	95.50	82.80	12.70
39	168.85	109.40	59.45	98.87	78.92	19.95
40	152.46	109.94	42.52	73.11	67.21	5.90
50	209.47	132.97	76.50	93.50	71.15	22.35
51	213.35	140.82	72.53	125.52	103.14	22.38
52	217.15	141.24	75.91	131.94	108.93	23.01
53	165.41	106.45	58.96	102.96	81.41	21.55
54	184.58	119.61	64.97	108.98	88.44	20.54

NOTE.—Samples 35, 36, 38, and 50 were obtained from Davao Province; 39, 53, and 54 from Palawan Province; 37 from Tayabas Province; 40 from Nueva Ecija Province; 51 and 52 from Surigao Province.

As shown in Table 1, the saponification, acid, and ester numbers of the copal were decreased very considerably by the running process. These lower acid values are desirable when the copal is intended for making oil varnishes.

Analysis.—Preliminary experiments were carried out to ascertain a convenient procedure for separating the constituents in Manila copal that has been run. A method that gave satisfactory results is outlined in Fig. 3.

The powdered run copal (50 grams) is treated with a mixture consisting of equal parts (250 cc each) of benzene and aldehyde-free absolute alcohol.[4] The mixture is heated on a steam bath for about a half hour to dissolve the resin.

Ordinary alcohol contains aldehydes that polymerize to form resins. Aldehyde-free absolute alcohol was used throughout this work when alcohol was required as a solvent.

Insoluble matter.—If much insoluble matter is present the heating is continued for about two hours longer or until all the soluble resin is apparently dissolved. The mixture is then allowed to stand overnight to facilitate the subsequent filtration. The mixture is filtered through a large weighed filter paper. The insoluble matter is washed with the benzene-alcohol mixture and the filtered washings are added to the soluble copal solution. The filter with the insoluble matter is allowed to drain on layers of filter paper, after which it is dried in an oven at 50 to 60°C. for about 15 hours or longer until the weight of the insoluble matter (2) becomes constant. When much residue is present the drying may be facilitated by opening the partly dried filter and spreading the residue in a somewhat thin layer. Use of a vacuum oven also hastens the drying.

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[4] Dunlop, F. L., Journ. Am. Chem. Soc. 28 (1906) 397.

Soluble copal.—The filtrate from the insoluble matter is a benzene-alcohol solution that contains the soluble portion of the run copal, which consists of thermal constituents, resenes, and

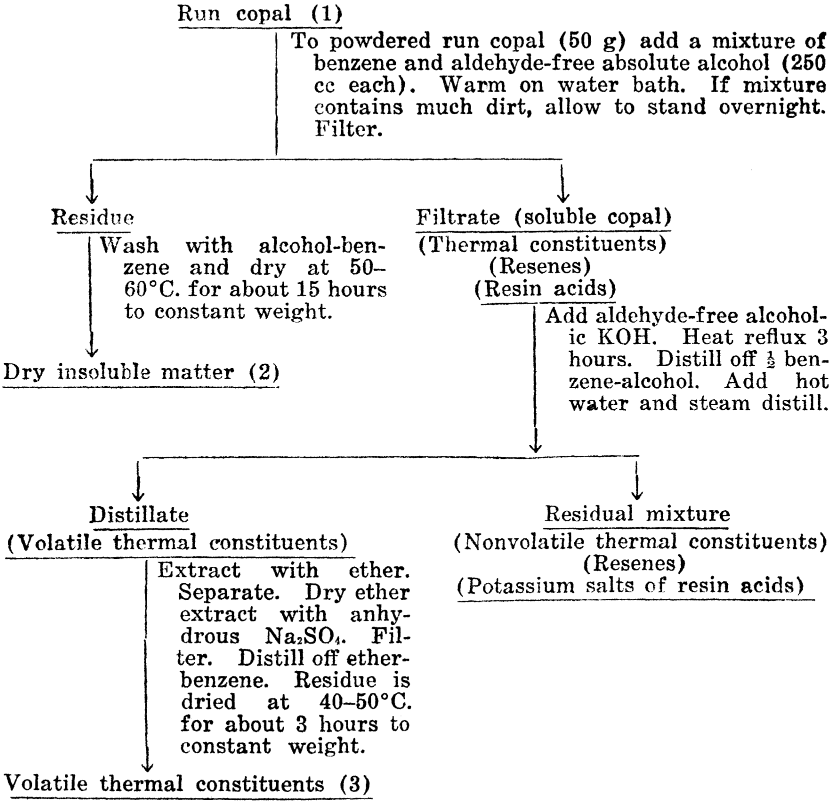
Run copal (1)
To powdered run copal (50 g) add a mixture of benzene and aldehyde-free absolute alcohol (250 cc each). Warm on water bath. If mixture contains much dirt, allow to stand overnight. Filter.
Residue
Wash with alcohol-benzene and dry at 50–60°C. for about 15 hours to constant weight.
Dry insoluble matter (2)
Filtrate (soluble copal)
(Thermal constituents)
(Resenes)
(Resin acids)
Add aldehyde-free alcoholic KOH. Heat reflux 3 hours. Distill off ½ benzene-alcohol. Add hot water and steam distill.
Distillate
(Volatile thermal constituents)
Extract with ether. Separate. Dry ether extract with anhydrous Na₂SO₄. Filter. Distill off ether-benzene. Residue is dried at 40–50°C. for about 3 hours to constant weight.
Volatile thermal constituents (3)
Residual mixture
(Nonvolatile thermal constituents)
(Resenes)
(Potassium salts of resin acids)

FIG. 3. Analysis of run Manila copal.

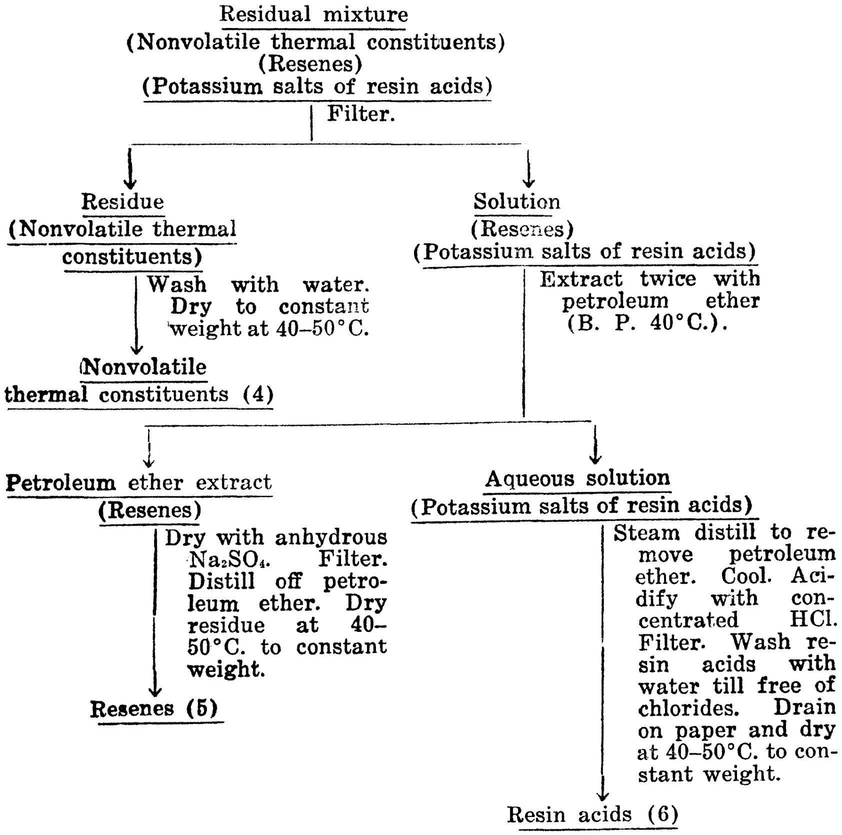
Residual mixture
(Nonvolatile thermal constituents)
(Resenes)
(Potassium salts of resin acids)
Filter.
Residue
(Nonvolatile thermal constituents)
Wash with water. Dry to constant weight at 40–50°C.
Nonvolatile thermal constituents (4)
Solution
(Resenes)
(Potassium salts of resin acids)
Extract twice with petroleum ether (B. P. 40°C.).
Petroleum ether extract
(Resenes)
Dry with anhydrous Na_2SO_4. Filter. Distill off petroleum ether. Dry residue at 40–50°C. to constant weight.
Resenes (5)
Aqueous solution
(Potassium salts of resin acids)
Steam distill to remove petroleum ether. Cool. Acidify with concentrated HCl. Filter. Wash resin acids with water till free of chlorides. Drain on paper and dry at 40–50°C. to constant weight.
Resin acids (6)

FIG. 3. Analysis of run Manila copal.—Continued.

resin acids. Volatile matter is expelled from the copal during the running (thermal) process and the new substances formed in the run copal we called thermal constituents.

Volatile thermal constituents.—The benzene-alcohol solution of the run copal is treated with an alcoholic solution of potassium hydroxide sufficient to neutralize the resin acids and to saponify any saponifiable material contained in the copal solution. The constants of the run copal suggest the required amount of alkali to be used. About 10 per cent excess should be employed. After the addition of the alkali the mixture is boiled (reflux) for about 3 hours to complete the saponification. About half the solvent is then removed by distilling. The residue is treated with hot water and steam distilled for about 18 hours until the distillate no longer has an odor of volatile thermal constituents—substances produced in the copal during the running process and which may be steam distilled from the alkaline solution.

The distillate containing the volatile thermal constituents is extracted with ether. The ethereal extract is dried with anhydrous sodium sulphate, filtered, and the solution distilled on a water bath. The residue is then dried at a temperature of 40 to 50° C. for about 3 hours to constant weight. This process gives the volatile thermal constituents (3) separated from the run copal.

Nonvolatile thermal constituents.—After the volatile thermal constituents are removed by distilling, the residual solution is filtered to get the insoluble, nonvolatile, thermal constituents. These are washed with a small amount of water and the aqueous washings added to the solution containing the resenes and potassium salts of resin acids. The filter containing the nonvolatile thermal constituents is drained on layers of filter paper and then dried for, perhaps, several days at a temperature of 40 to 50°C. to constant weight. The nonvolatile thermal constituents (4) are thus obtained.

Resenes.—The solution containing the resenes and potassium salts of resin acids is extracted twice with petroleum ether (B. P. 40°C.). The petroleum ether extracts are combined and dried with anhydrous sodium sulphate and filtered. The petroleum ether is then removed by distilling and the residue dried at a temperature of 40 to 50°C. to constant weight. The product represents the resenes (5).

Resin acids (6).—The aqueous solution containing the potassium salts of resin acids is steam distilled to remove petroleum ether. It is then cooled to room temperature and acidified with concentrated hydrochloric acid to precipitate the resin acids. The acids are removed by filtering and washed with water until free of chlorides. The filter containing the acids is then drained on layers of filter paper. The residue is finally dried for some days at a temperature of 40 to 50°C. to constant weight, giving resin acids (6).

This method of analysis enables us to separate the run copal into its various constituents consisting of insoluble matter, thermal constituents, resenes, and resin acids.

A sample of Manila copal from Palawan Province was run at a temperature of 300 to 315°C. for 5 hours. The constants and analysis of this copal, before and after running, are given in Table 2. Also included are the constants of the resin acids from the natural and run copal. Similar results are given in Table 3.

TABLE 2.—*Composition of raw Manila copal before and after running.*

Constants and analysis.	Copal.	
	Before running.	After running.
Constants:		
Saponification No.	170.90	99.80
Acid No.	108.89	80.31
Ester No.	62.01	19.49
Analysis:		
Insoluble matter	0.70	0.56
Terpenes	15.03	----------
Resenes	7.50	9.48
Thermal constituents:		
Volatile	----------	10.44
Nonvolatile	----------	3.65
Resin acids	74.55	74.71
Water (by difference)	2.22	----------
Total	100.00	98.84
Constants of resin acids:		
Saponification No.	177.67	108.65
Acid No.	144.31	88.95
Ester No.	33.36	19.70

NOTES.—The copal was run (heated) at 300 to 315° C. for 5 hours. The sample before running was soft copal, not refined, from Palawan Province.

TABLE 3.—*Composition of Manila copal before and after running.*

Constants and analysis.	Copal.	
	Before running.	After running.
Constants:		
Saponification No.	178.83	102.25
Acid No.	115.85	84.19
Ester No.	62.98	18.06
Analysis:		
Terpenes	12.65	----------
Resenes	5.27	7.06
Thermal constituents:		
Volatile	----------	9.45
Nonvolatile	----------	2.50
Resin acids	80.64	80.51
Total	98.56	99.52

NOTES.—The copal was run (heated) at 300 to 315° C. for 5 hours. The sample before running was refined copal that contained no insoluble matter.

The process of running not only gave a decided decrease in all the constants, but also made a marked difference in the composition of the copal. The terpenes and water in the natural copal were removed by running but the insoluble matter and resenes were not greatly affected. Running did not appreciably change the amount of resin acids in the copal. However, the nature of the acids was affected considerably, as shown by the reduction in the acid number.

During the running (thermal processing) of the copal new substances are formed in the run copal. As we have not yet identified these substances we designated them by the term "thermal constituents." They are of two kinds, volatile and nonvolatile. The volatile may be steam distilled from the alkaline solution, while the nonvolatile remains behind. These thermal constituents were probably the result of thermal side reactions that occur during the running process.

The analyses of two more samples of run copal are given in Table 4. These data are similar to those for the run copal in Tables 2 and 3.

TABLE 4.—*Composition of run copal.*

Composition.	Sample.	
	53.	54.
Insoluble matter	0.41	-----
Resenes	9.00	8.13
Thermal constituents:		
Volatile	9.93	10.03
Nonvolatile	1.51	2.30
Resin acids	78.59	78.33
Total	99.44	98.79

NOTES.—Sample 54 was obtained by running a refined copal that contained no insoluble matter. The constants of these samples, both before and after running, are given in Table 1.

In Table 5 is given a comparison of the amount of thermal constituents developed in four samples of Manila copal during the running process. These data were compiled from the results presented in Tables 2, 3, and 4.

The amount of volatile thermal constituents formed during the running process varied from 9.45 to 10.44 per cent, while the nonvolatile varied from 1.51 to 3.65 per cent. This variation is probably due to somewhat irregular heating during the running process. Differences in the composition of the natural copal before running may also influence the results.

TABLE 5.—*Comparison of thermal constituents developed in run copal.*

Thermal constituents.	Tables.			
	2.	3.	4.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Volatile	10.44	9.45	9.93	10.03
Nonvolatile	3.65	2.50	1.51	2.30
Total	14.09	11.95	11.44	12.33

NOTE.—These data were compiled from Tables 2, 3, and 4.

SUMMARY

Manila copal is a resin that is used principally for making high-grade varnishes. It is obtained from the bark of *Agathis alba* (Lam.) Foxw.

Soft Manila copal is not soluble in drying oils. In order to make oil varnishes with this resin it is customary to heat it to remove volatile constituents and decomposition products. This heating (thermal) process is known in the varnish industry as running.

In order to ascertain the difference in the composition of the copal, before and after running, a method was devised for analyzing the run copal. Details of this analytical procedure are given in this paper.

The constants of the copal were determined both before and after running. The saponification, acid, and ester numbers were decreased very considerably by the running process. These lower acid values are desirable when the copal is intended for making oil varnishes.

The copal was analyzed both before and after running. As a result of the running process the terpenes and water in the fresh copal were eliminated. The insoluble matter and resenes were not greatly affected. The running did not appreciably change the amount of resin acids in the copal. However, the nature of the acids was affected considerably as shown by the reduction in the acid number.

During the running (thermal processing) of the copal new substances are formed in the run copal. As we have not yet identified these substances we designated them by the term "thermal constituents." They are of two kinds, volatile and nonvolatile. The volatile may be steam distilled from alkaline solution while the nonvolatile remain behind.

Four samples of the run copal were analyzed. The amount of the thermal constituents in these samples varied from 9.45 to 10.44 per cent for the volatile and 1.51 to 3.65 per cent for the nonvolatile.

We expect to investigate different thermal constituents which are gradually formed during the running (thermal) process.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Analysis of Manila copal.
2. Preparation of run Manila copal.
3. Analysis of run Manila copal.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Careers in the Mineral Industries; a Vocational Booklet for Use in Secondary Schools. By Thomas T. Reed. Published by the American Institute of Mining and Metallurgical Engineers through the Seeley W. Mudd Memorial Fund. 1st rev. ed. New York, 1939. 32 pp., Price, paper, $0.25.

This pamphlet, presented in question and answer form, gives the scope of the different careers in the mineral industries. It points out how courses leading to these careers can be pursued with advantage; what it costs to pursue these courses; and what opportunities await one in these fields after graduation. It lists the American colleges and schools offering curricula in mineral technology. The pamphlet is primarily intended to guide vocational councellors and advisers, principals, and teachers called upon to help young people plan a career in the mineral field. It is invaluable in that it presents facts about these careers in a concise and convenient manner.—R. T. S.

Audels Diesel Engine Manual. By A. B. Green and R. A. Zoeller. New York, Theo. Audel & Co. 354 pp., illus. Price, $2.

The Audels-Diesel engine manual is a practical and concise treatise dealing with the theory and practical operation, maintenance, construction, and repair of modern Diesel engines, with profuse illustrations.

This book is based on wide experience on the part of the authors in servicing and operation. It is an essential guide for those who are interested in acquiring a general knowledge about the fundamental and operating principles of high speed Diesel engines and semi-Diesel engines, including practical pointers on operation, inspection, maintenance, and repair of both four-stroke and two-stroke cycle Diesel engines. It is very helpful to students, owners, operators, mechanics, salesmen, and engineers.—B. R. D.

Poultry Practice. By Leland Bushnell with the Collaborations of Edwin J. Frick, Marvin J. Twiehaus, and others. Chicago, Veterinary magazine corporation, 1940. 160 pp., illus. Price, $1.

The articles in this book were published in the past issues of Veterinary Medicine, but I came to appreciate the value of the correlated subjects as a whole only when I read them again in book form. Although the book begins and ends by challenging the veterinary profession on the high rate of poultry mortality and the control of diseases, it contains valuable scientific information for the veterinarian on poultry problems. It contains papers from many outstanding investigators on the subject, and undoubtedly will prove helpful to those interested in advancing the poultry industry. Aside from the broad subjects it deals with, like poultry management, sanitation, breeding and nutrition, it emphasizes the common poultry diseases and parasites, together with the known methods of control, treatment, and eradication.

Included in the collection is the rôle played by the avian embryo, as a valuable aid in the study of diseases and in the preparation of vaccine, as well as avian surgery, which is of interest to veterinary practitioners. Indeed, this book should prove highly useful to practitioners who should be aroused to take a deep interest in serving the poultry industry as they serve other branches of animal husbandry. It gives the layman a graphic picture of the veterinary profession and thus enables him to avail himself of the services of a skilled veterinarian.—B. B. B.

The Autobiography of an Egret. By E. A. McIlhenny. New York, Hastings house, 1939. 58 pp., illus. Price, $2.

This little book portrays the life history of the American egret in the form of an autobiography. Beautiful photographs taken from life, some of which must have been extremely difficult and risky to take, are presented in a sequence that describes almost all the phases of the life of this bird. The text is written in simple language that makes it easy reading even for children. This book should be included in the collection of every lover of nature and every children's library.—C. G. M.

The Story of the Plant Kingdom. By Merle C. Coulter. Chicago, The University of Chicago press, 1940. 270 pp., illus. Price, $2.50.

This work, consisting of 20 chapters, with numerous illustrations and footnotes, presents the essentials of botanical science in a very simple and convenient manner by minimizing the use of the very technical and detailed terminology that is quite common to most textbooks in botany, and thus gives the subject matter much interest for a beginner in botany. The presentation of brief but coherent sketches of the plant kingdom, followed by an analytical study of the functions and environmental relationships of living organisms, makes the text wholesome reading that will surely be of great use to teachers in our high schools.—J. B. J.

Accepted Foods and Their Nutritional Significance. Compiled by the Council on Foods of the American Medical Association, Chicago. 492 pp. Price, $2.

This book gives an account of the satisfactory food products submitted to the Council on Foods of the American Medical Association. General classes of foods are listed as follows: Fats, oils, and their products; fruit juices; canned and dried fruits and fruit products; grain and grain products; infant foods; meat, fish, and sea foods; milk and milk products; sugars and syrups; vegetables; beverages, coffee, tea, and the like; and flavoring extracts.

This publication is a handy reference manual of interesting and instructive information on the composition and calorific value of foods. It explains the rules and regulations pertaining to the composition and advertising of foods as adopted by the Council.

Numerous analyses of foods and food products are recorded. Most of these reports have the common food determinations (ash, fat, nitrogen, and other elements), but are lacking in the important vitamin constituents. However, the mineral contents (calcium, phosphorus, and iron) of a number of fruits and vegetables are included.

This volume will serve as a valuable addition to the library of anyone interested in nutrition, the chemistry of foods, and the medical rules and regulations pertaining to the food industry. —A. P. W.

Medical Education in the United States 1934–1939. Prepared for the Council on Medical Education and Hospitals of the American Medical Association. By Herman G. Weiskotten and others. Chicago, American Medical Association, 1940. 259 pp., illus. Price, $1.

This book contains an extensive and comprehensive report prepared for the Council on Medical Education and Hospitals of the American Medical Association by a committee composed of two medical school deans, the Secretary, and a member of the Council, and gives the result of a survey made of sixty-six medical schools in the United States during 1934 and 1935 together with developments up to 1939. The sources of information were :(1) the answers of deans to a set of questionaires sent out by the Council, (2) the result of visits by the Chairman, Doctor Weiskotten, and "companion," and (3) in many instances, catalogs, laboratory outlines, and other literature dealing with the conduct of courses. The report is mainly a factual exposition and summary of the results of the survey, and neither makes comments on, nor publishes the evaluation of, any particular medical school or department. Under separate and well-apportioned chapters the report describes the committee's findings regarding the organization and administration of the sixty-six medical schools, their educational programs, instructional personnel, library and clinical facilities, as well as student and financial administration. It has also separate chapters dealing with each of the preclinical and clinical departments of the various medical schools, especially contrasting the conditions found in the ten highest and the ten lowest ranking departments, the evaluation having been based on physical facilities, personnel, educational program, and research and scientific interest.

The facts and comments of the survey report should be interesting and instructive to administration officers of universities and medical schools, to their agencies such as the committee on admission, on promotion, on catalog and curriculum, and to heads of departments.—E. B.

Medicolegal and Industrial Toxicology. By Henry J. Eilmann. Philadelphia, The Blakiston Company, 1940. 324 pp. Price, $3.

This small volume, which is divided into five parts, such as poisons and drugs, criminal investigations, medicolegal examinations of miscellaneous nature, industrial poisoning, and occupational diseases, is a useful, important, and valuable guide to medicolegal officers and coroners, health and industrial physicians, lawyers, insurance adjustors, forensic toxicologists, laboratory experts, and many others. The chemical composition, physical and chemical properties, toxic effects, symptoms, postmortem signs, isolation, and chemical detection of the common industrial and occupational poisons and poisonous drugs, are briefly but adequately described. The sensitivity limit of the detection of hydrocyanic acid or cyanides by the prussian blue test as performed and reported by the author is 1:5,000,000 dilution, which is 100 times more than the reported and generally accepted concentration.

The simple methods of determining blood, seminal, and other stains, fibers and hairs, and arson chemicals; and the detection and determination of death by strangulation, throttling, hanging, choking, drowning, and many other cases connected with criminal investigations are reasonably presented. The discussion and presentation of every subject contained in this book emphasize, however, its applications to our Workmen's Compensation Law, Act No. 3428 as amended, and to our Employers' Liability Law, Act No. 1874, both of which prescribe and regulate the compensation for employees and the responsibilities of employers in cases of personal injury and death.—G. Q. Q.

The Malarial Therapy of General Paralysis and Other Conditions. By William H. Kupper. Ann Arbor, Michigan, Edwards Brothers, Incorporated, 1939. 155 pp. Price, $2.25.

The author, formerly resident physician of the Florida State Hospital, draws upon his experience in this comparative study of malarial therapy. His own personal cases are not many, but they form a useful supplement to the study which he makes of the results of other workers in the same field.

The most important chapters are those in which he traces the development of the therapy and those in which he describes the different aspects of the therapy. His remarks about the gaps in our knowledge of syphilitic infection are particularly thought provoking, especially with the recent revival of theories concerning a possible exogenous stage in the life cycle of *T. pallidum*, possibly in an insect. The theory goes back to Schaudinn over thirty years ago, and was revived by McDonagh in 1915. Are the causative organisms of syphilis, yaws, malaria, leprosy, and relapsing fever closely related? Suggestive evidence is not lacking. The Wasserman reaction is more consistently given by these five diseases than any other, a life cycle analogous to the life cycle of the plasmodia has been reported, and finally the remissions obtained with malarial therapy do not seem to depend on the production of the fever alone.

The discussion of the malarial therapy of general paralysis is comprehensive. The indications and contraindications, the different methods of inoculation, the advantages and disadvantages of mosquito over syringe inoculation, the course, symptomatology, complications, and prognosis are described. Of particular importance are the notes on the management of the course, the counting of parasites, and the treatment of untoward symptoms. Typical and useful case histories, temperature records, tables, and charts are appended. The statistics of different investigators are included. From them the reader can get an illuminating idea about the work being done in this specialty, the failures and successes, the obstacles already surmounted, and the problems that remain to be solved.—A. B. R.

The Diagnosis and Treatment of Pulmonary Tuberculosis. By John B. Hawes and Moses J. Stone. 2d. ed., rev. by Moses J. Stone, with a foreword by Richard C. Cabot. Philadelphia, Lea & Febiger, 1940. **260 pp., illus. Price, $2.75.**

The title of this book might as well have been "Essentials in Pulmonary Tuberculosis." It is a good manual for the lung specialist but is altogether too brief for the beginner. The chapters on history taking, symptomatology, physical examination, and differential diagnosis will readily appeal to the medical man who has had hospital and teaching experience, but may fall short of the needs of the physician at large who has lost contact with his college or hospital since his graduation days. The discussion on collapsotherapy, particularly pneumothorax, is too brief to be of much value to the practitioner who wants to be informed of the actual technique. This part of the book might have been expanded at the expense of chapters on heliotherapy, mental aspects of the tubercular, and rules for clinic procedures. The question of diet in tuberculosis is well presented as sensible and timely advice against the prevalent practice of indiscriminate overfeeding.

As a whole the authors should be commended on their effort. They have brought into the world a worthwhile contribution to medical science, particularly on the subject of tuberculosis. This book should be added to the collection of every medical man and every medical library.—W. V.

RECEIVED

Blue book of the inauguration of the Commonwealth of the Philippines and the induction into office of Manuel L. Quezon, 1st president of the Philippines, and Sergio Osmeña, 1st vice president of the Philippines. Manila, November 15, 1935. 239 pp., illus., plates, ports., map. Price, ₱3; postage, ₱0.20.

COLLINGWOOD, G. H. Knowing your trees. Washington, D. C., The American forestry association, 1937. 109 pp., illus. Price, $1.

KAUFFMAN, ERLE. Kingdom of the trees. Chicago, Reilly and Lee, 1940. 122 pp., illus. Price, $2.

KUPPER, WILLIAM H. Malarial therapy of general paralysis and other conditions. Ann Arbor, Michigan, Edwards Brothers, 1939. 155 pp., tables, charts, illus. Price, $2.25.

LEVISON, JACOB J. The home book of trees and shrubs. With an introduction by Samuel J. Record. New York, Simon and Schuster, 1940. 424 pp., front., illus. Price, $5.

Our government: what it is doing for us. Manila, Bureau of Printing, November 15, 1940. 168 pp., illus. Price, ₱0.50.

SAUNDERS, L. H. Vegetable growing in the tropics. London, Oxford university press, 1940. 120 pp. Price, 3s/6d.

Vitamin E. A symposium held under the auspices of the Food Group (Nutrition Panel) of the Society of Chemical Industry on Saturday, April 22d, 1939, at the School of Hygiene and Tropical Medicine, Keppel Street, London, W. C. 1, England. New York, Chemical publishing co., inc., 1940. 88 pp., illus. Price, $2.

THE PHILIPPINE JOURNAL OF SCIENCE

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EXPERIMENTAL STUDIES ON THE CURATIVE TREATMENT OF SURRA IN NATIVE HORSES IN THE PHILIPPINES, III.[1]

WITH A REPORT ON THE RESULTS OBTAINED IN BRITISH NORTH BORNEO

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University of the Philippines, Manila

The present contribution is the result of further studies on the chemotherapy of surra. From the literature reviewed it appears that Bubberman, Douwes, and van Bergen(4) were the first workers to investigate extensively the value of naganol in combination with either atoxyl or tartar emetic or both against equine surra in the Dutch East Indies. Fractional small and single large doses at various intervals were tried. At best the results obtained were noted with naganol and atoxyl in nonlethal but slightly toxic doses and administered simultaneously. Working with four naturally infected horses, Bakker(1) tried naganol and tartar emetic, and on two occasions atoxyl was employed in addition. Out of the four cases treated, two recovered and the rest developed paresis about two months after the course of the treatment. It was not stated, however, which of the two methods gave satisfactory results. In India, C. Kahan Singh,(7) with a view to reducing the expense involved in the treatment of surra, investigated the merit of naganol with tartar emetic. With 114 horses employed, he reported a recovery of about 80 per cent. The course of the treatment was spread over a period of one month, during which small fractional doses were given. Zijp(12) checked the work of his predecessors in the Netherlands Indies. He employed naganol and atoxyl on about 200 equines. Although the animals treated were not observed closely, the author noted fairly good results if the treatment was begun sufficiently early.

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[1] Aided by a special research grant from the Board of Regents, University of the Philippines.

In the Eleventh International Congress held in London, Bubberman(3) reported that naganol with atoxyl administered simultaneously in large doses is attended with 60 per cent recovery in early cases. Hornby(6) obtained the best results in the treatment of equine surra with naganol alone or in combination with other drugs, as tartar emetic, antimosan, sulfarsenol, and others. Bakker(2) reinvestigated the value of naganol in combination with atoxyl, tartar emetic, and tryparsamide. Of the 12 horses treated, 6 were declared cured, the most effective combination being naganol and tartar emetic. In the Philippines, following closely the fractional method and using naganol in combination with tartar emetic and fuadin, Topacio(8) recorded 6 horses cured out of 11 experimentally infected and 29 out of 40 naturally infected. The course of the treatment was spread over a period of one month. Topacio attributed the high mortality in the experimental animals mainly to the highly virulent strain of trypanosome employed.

In view of the conflicting findings reported by various investigators on the merit of the combined treatment—that is, naganol with atoxyl on one hand, and naganol and tartar emetic on the other, an attempt was made to determine the value of each combination in nonlethal but slightly toxic doses. The results are given in the present paper.

MATERIALS AND METHODS

Animals used.—The same species of animals as those used in previously reported experiments were employed in this investigation.(9, 10) The bulk of the horses used in the field trials were in British North Borneo. The strain of trypanosome used in the controlled experiments was the same as that used in the two previous reports of this series.(9, 10) The strain met with in British North Borneo was identical in both morphology and biological behavior with the Philippine surra trypanosome. In fact, a consideration of other known factors, such as the proximity of the infected district to the Philippines and the occasional clandestine entrance of Philippine animals, and other circumstances, suggests strongly that the outbreak of surra in British North Borneo is of Philippine origin.(11)

Drugs used.—Besides naganol which had been previously used, atoxyl and the sodium salt of antimony tartrate were principally employed. The latter was selected because it is believed to be less toxic than the potassium salt. While atoxyl was secured through a local druggist, the sodium salt of antimony tartrate was imported in tablet form directly from Burrough Wellcome and Company, London, England.

Procedure.—The technic given in the initial report(9) was closely followed. In accordance with Paul Ehrlich's well-known dictum "Therapia sterilisans magna" in most of the experiments the drugs were administered in sublethal doses.[2]

EXPERIMENTS AND RESULTS

THE TREATMENT OF EQUINE SURRA WITH SIMULTANEOUS INJECTION OF NAGANOL AND ATOXYL

To determine the efficiency of the simultaneous intravenous injection of naganol and atoxyl against surra among Philippine horses, experiments 1 to 7 were carried out. A detailed description of each of the experiments follows.

Experiment 1.—Horse 75. Weight 175 kilograms.

March 18, 1936.—Admitted in the college hospital; microscopic examination showed the blood teeming with surra trypanosomes (++++). The animal had been noted to be with œdema in the pendant portion of the abdomen for some time. Other horses in the same stable had been observed to be similarly affected and died subsequently. The temperature was 39.8°C.; animal lethargic with pale mucous membrane. Animal inoculation positive; complement-fixation test positive (+ + + +). The horse was given intravenously the initial treatment of 2.63 grams of atoxyl in 5 per cent concentration and 1.75 grams of naganol in 10 per cent sterile solution in distilled water.

March 19.—Blood negative. Temperature 38.7°C. Œdema of the prepuce, penis, abdomen, muzzle, and eyelids; horse decidedly depressed but appetite fair. Subcutaneous injection, 10 cc camphorated oil.

March 20.—Blood negative. Temperature 38°C.; condition same as above. Camphorated oil injection repeated.

March 21 to 26.—Blood negative. Condition slightly improved; œdema subsided somewhat but periproctitis developed.

March 27.—Blood negative. Atoxyl and naganol treatment repeated; dose of naganol reduced to 0.875 gram, concentration remaining the same as initial injection.

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[2] For a detailed description of the procedure, previous works may be consulted.(9-11)

March 28 to April 5.—Blood negative. Temperature normal.

April 6.—Blood negative. Treatment with trypanocidal drugs repeated; horse quite active; appetite good.

April 8.—Blood negative. Complement-fixation test positive (+ + + +); condition same as above.

April 9 to 12.—Blood negative. Temperature never above 38°C.

April 13.—Blood negative. Weakness in hind quarters, unable to get up without assistance, appetite fair.

April 14 to 20.—Blood negative; condition almost the same; appetite good.

April 21.—Blood negative. The animal was down, could not stand even when helped to its feet, hence a sling was adjusted; emaciation developing.

April 22.—Blood negative. Given intravenously 50 cc of a 10 per cent solution of calcium gluconate.

April 23.—Blood negative. Horse getting weaker; paresis of the hind quarters more marked; appetite good.

April 24.—Blood negative. Calcium gluconate treatment repeated; 20 cc of cerebrospinal fluid withdrawn and injected intraperitoneally to two white rats.

April 25 to May 1.—Blood negative. Inspite of good appetite weakness of the hind legs more marked; animal depressed and lethargic.

May 2.—Blood negative. Horse found in a recumbent position unable to stand even when assisted; 20 cc cerebrospinal fluid withdrawn by means of intrathecal puncture and injected immediately into two white rats.

May 4.—Horse dead, 27 days after last treatment.

May 7 to 20.—All four white rats negative by blood examination.

May 27.—Rats tested for susceptibility; all caught infective inoculation after 4 days and died subsequently.

Experiment 2.—Horse 76. Weight 124.5 kilograms.

May 18, 1936.—Infected subcutaneously with surra trypanosomes.

May 24.—Blood positive (+). Temperature 38.5 C.; complement-fixation test negative.

May 25.—Blood positive (+ +). Temperature 40.8°C.

May 26.—Blood positive (+ + +). Temperature 39.4°C. Animal slightly depressed with dyspnœa.

May 27.—Blood positive (+ + + +). Temperature 38.5°C.

May 28.—Blood positive (+ +). Temperature 39°C.; animal depressed.

May 29 and 30.—Blood negative. Temperature 38.4°C.

May 31.—Blood positive (+ + +). Temperature 39°C.

June 1.—Blood positive (+ + + +). Temperature 38.8°C.

June 2 and 3.—Blood positive (+). Temperature 39.1°C.; dyspnœa quite marked; œdema of the posterior extremities developed.

June 4, 5, and 6.—Blood positive (+ + + +). Temperature 1 to 2 degrees above normal.

June 7.—Blood positive (+ + +). Temperature 37.8°C.

June 8.—Blood negative. Temperature 38°C.; œdema of the prepuce noted for the first time. Animal reweighed (130 kilograms); 25 cc of cerebrospinal fluid obtained by intrathecal puncture and injected immediately intraperitoneally into two white rats each rat receiving 10 cc of the fluid. Balance tested for complement-fixing bodies, results negative. On the other hand, blood reacted positive (+ + + +) to the test. Horse given a simultaneous intravenous injection of atoxyl and naganol in doses of 1.95 and 1.30 grams, respectively, dissolved in enough sterile distilled water to make a concentration of 5 per cent of the former and 10 per cent of the latter drug.

June 9.—Blood negative. Temperature 37.6°C.; animal depressed; head held low; marked œdema of the prepuce, hind legs, and muzzle.

June 10 to 12.—Blood negative. Temperature 37.5°C. Condition unchanged.

June 13.—Blood negative. Temperature 37.9°C. Œdematous swelling of hind extremities, muzzle, and prepuce considerably subsided. Blood of the rats positive (+).

June 14.—Blood negative. Temperature 38.1°C. Treatment repeated. Dose of atoxyl increased to 2.6 grams, naganol reduced to 0.65 grams.

June 15.—Blood negative. Temperature 38.2°C. Condition slightly improved.

June 16 and 17.—Blood negative. Temperature normal.

June 18.—Blood negative. Temperature 38°C. Perirectal eruption noted. Positive rat died, the other noted positive for first time on examination of tail blood.

June 19.—Blood negative. Temperature 36.5°C. Appetite good; horse quite active; œdematous swelling completely disappeared.

June 20.—Blood negative. Temperature 37.8° C. Third course of treatment given, observing same doses as second. Second positive rat died.

June 21 to 31.—Blood negative. Temperature 38.3°C. Condition fair; appetite good.

July 1.—Blood negative. Temperature 38.4°C. Appetite good but emaciation beginning to appear.

July 2 to 31.—Blood negative. Temperature 37.9° C. Condition fair.

August 1.—Blood negative. Slight dyspnœa noted; temperature 37.8° C.; appetite good.

August 2 to 11.—Blood negative. Temperature normal.

August 12.—Blood negative. Temperature 37.8°C. Complement-fixation test (+ + +) in one tube and (+ +) in the other.

August 14.—Blood negative. Temperature 37.6°C. Weakness of hind legs; animal unable to get up without assistance.

August 25 to 18.—Blood negative. Temperature normal; paresis of hind legs marked; appetite good.

August 19.—Blood negative. Temperature 36.7° C. Animal down, unable to gain its feet even when assisted. Intrathecal puncture performed but difficulty was encountered in withdrawing cerebrospinal fluid. Only about 10 cc mixed with blood was obtained and injected into three white mice. The horse died not long after the operation.

August 26.—Blood of one mouse positive (+); other two negative.

August 30.—Positive mouse dead; one of the two negative mice became positive (+ + +) and died the day following. The last mouse did not developed surra during an observation period of 30 days after inoculation with cerebrospinal fluid. At the end of the period, it was tested for susceptibility; it caught the disease 7 days afterwards and died 5 days later.

Experiment 3.—Horse 77. Weight 138 kilograms.

October 21, 1936.—Infected intracutaneosuly with surra blood.

October 25.—Blood positive (+). Temperature 38.2°C.

October 27.—Blood positive (+ + +). Temperature 40.7° C. Animal depressed.

October 28.—Blood positive (+ +). Temperature 38.9° C.

October 29.—Blood positive (+ + +). Temperature normal. Animal depressed.

October 30.—Blood positive (+ + + +). Temperature 39.9° C.

October 31.—Blood positive (+ + + +). Temperature 38.8°C. Condition same as October 29.

November 1.—Blood positive (+). Temperature normal. Animal depressed with slight œdema of lower portion of hind legs.

November 2.—Blood positive (+ +).

November 3.—Blood positive (+ + + +). Temperature 39.8°C. Animal dyspnœic; appetite good.

November 4.—Blood positive (+ + + +). Temperature normal. Condition same as above.

November 5.—Blood positive (+ +), watery. Temperature 39.5° C.

November 6.—Blood positive (+ + +). Temperature normal. Animal depressed but with good appetite.

November 7.—Blood positive (+). Temperature 1.4°C. above normal. Slight œdema of ventral portion of abdomen noted for first time.

November 8.—Blood positive (+). Temperature returned to normal. Thirty cc of cerebrospinal fluid obtained and injected into two white rats, each, receiving approximately 15 cc. Microscopic examination of the centrifuged cerebrospinal fluid showed surra trypanosomes.

November 9.—Blood positive (+ +). Temperature 38.6°C. Animal reweighed (125 kilograms). Injected simultaneously with 2.5 grams each of atoxyl and naganol dissolved in sufficient sterile distilled water to make 5 and 10 per cent concentration, respectively.

November 10.—Blood negative. Temperature 39.8° C. Appetite good; œdematous swelling of the muzzle noted; visible mucous membrane icteric.

November 11.—Blood negative. Temperature returned to normal. Condition same as above.

November 12.—Blood negative. Temperature normal. Animal depressed; appetite good; perirectal eruption developed, which disappeared in the course of 15 days; complement-fixation test positive (+) in one tube, negative in the other.

November 13.—Blood negative. Animal weaker than yesterday. Both rats positive (+ + + +).

November 14.—Blood negative. Temperature normal. Condition same as above.

November 15 and 16.—Blood negative. Condition slightly improved; appetite good. Rats positive (+ + + +).

November 17.—Blood negative. White rats dead.

November 18 and 19.—Blood negative. Condition continued to improve.

November 20.—Blood negative. Complement-fixation test (++) in the first tube, (+) in the second, (±) in the third.

November 21 to 30.—Blood negative. Condition greatly improved.

December 1 to 21.—Blood negative. Temperature never above normal.

January 1 to 4, 1937.—Blood negative. General condition fair.

January 5.—Blood negative. Complement-fixation test negative in three tubes.

January 6 to February 14.—Blood negative. General condition fair.

February 15.—Blood negative. Inspite of good appetite the animal did not put on much weight. Complement-fixation test carried (±).

April 21 to May 31.—Blood negative. Complement-fixation test performed May 26 showed (+ +) in one tube and (+) in the other.

June 1.—Blood negative. Complement-fixation test (++) in the first tube and (+++) in the second.

June 2 to 22.—Blood negative. Complement-fixation test performed June 11 showed the same result as that performed June 1.

June 22.—Blood negative. Animal weighed (109 kilograms).

June 23 to September 1.—Blood negative. Inspite of fair appetite a progressive emaciation noted.

September 2.—Blood negative. Animal down, unable to get up without assistance.

September 3.—Blood negative. Horse depressed, greatly emaciated, weak, and in recumbent position.

September 4.—Blood negative. Animal unable to remain standing even when placed in sling. 20 cc of cerebrospinal fluid withdrawn and injected intraperitoneally in two white rats.

September 5.—Animal found dead, 294 days after treatment.

September 10.—White rats negative to microscopic examination of tail blood. Rats observed up to October 4 when susceptibility test was performed. Both rats went down with the disease 4 days later and died subsequently.

Experiment 4.—Horse 78. Weight 117 kilograms.

November 18, 1936.—Blood negative. Temperature 37.5° C. Inoculated intracutaneously with surra blood.

November 28.—Blood positive (+ +). Temperature 39.3°C.

November 30.—Blood positive (++++). Temperature 38.7°C. Appetite good.

December 2.—Blood positive (+). Temperature 37°C.

December 4.—Blood negative. Temperature normal.

December 5.—Blood positive (+). Animal slightly depressed.

December 6.—Blood positive (+ + +). Temperature 39.4°C. Slight dyspnœa noted; appetite good.

December 7.—Blood positive (+ + + +). Temperature 40.4° C. Horse depressed with head held low; appetite good.

December 8.—Blood positive (+). Temperature 39.1° C. Condition about same as above, with œdema of hind legs.

December 9.—Blood positive (+). Temperature 39.7°C. Animal reweighed (105 kilograms). 20 cc cerebrospinal fluid removed by intrathecal puncture and immediately injected into white rats.

December 10.—Blood negative. Temperature 39.3° C. Appetite fair; slight weakness of hind legs. Treated with a simultaneous injection of naganol and atoxyl in doses of 2.1 grams each dissolved in enough sterile distilled water to make up strength of solution as in the foregoing experiments.

December 11.—Blood negative. Temperature 37.8°C. Animal depressed, head held low, œdema of muzzle, eyelids, ears, limbs, and ventral portion of abdomen; appetite fair.

December 12.—Blood negative. Temperature 37.8° C. Appetite poor; œdematous swelling more marked.

December 13.—Blood negative. Temperature 38.3° C. Condition almost the same as above.

December 14—Blood negative. Temperature 38° C. Appetite fair; no visible improvement noted; horse distinctly depressed.

December 15.—Blood negative. Animal down in the morning; however, when helped to its feet, maintained a standing position; markedly dull with rapid respiration; anus relaxed. In the afternoon the horse was down again; decidedly weak in the hind quarters; given 10 cc camphorated oil subcutaneously.

December 16.—Horse found dead early in the morning.

Experiment 5.—Horse 79. Weight 102 kilograms.

December 17, 1936.—Infected intracutaneously with surra trypanosome.

December 24.—Blood positive (+). Temperature 37.8° C.

December 25.—Blood positive (+ + +). Temperature 38° C.

December 26.—Blood positive (+ + +). Temperature 39° C. Animal slightly depressed; appetite good.

December 27.—Blood positive (+ + + +). Temperature returned to normal. Condition same as yesterday.

December 28 and 29.—Blood positive (+ + + +). Temperature 1° C. above normal. Reweighed (92 kilograms).

December 30.—Blood positive (+ +). Temperature 37.2° C. Horse down in the morning but when led to its feet animal stood without assistance; slight weakness of hind legs noted; appetite good. Treated with atoxyl and naganol in doses of 1.80 grams each of same strength of solution as above. In the afternoon horse given one cc of fluid extract of nux vomica in water *per os*. Animal quite weak.

December 31.—Blood negative. Temperature 37.4°C. General condition about same as yesterday, appetite good. In the afternoon given fluid extract of digitalis and nux vomica one cc each in water *per os*.

January 1, 1937.—Blood negative. Temperature 37.1°C. Digitalis and nux vomica treatment repeated. Mucous membrane slightly icteric; animal quite weak.

January 2.—Blood negative. Temperature 37.4°C. Condition unchanged, same treatment as above.

January 3.—Blood negative. Animal sinking gradually; emaciation quite marked.

January 21.—Blood negative. Temperature 37.2° C. Marked weakness of hind legs noted. Complement-fixation test (+ + +) in one tube and (+ +) in the other.

January 22 to 30.—Blood negative. Animal greatly emaciated with weakness of hind quarters.

January 31.—Blood negative. Temperature subnormal. Ten cc of cerebrospinal fluid obtained and injected immediately into two white rats.

February 1.—Horse found dead.

February 6.—White rats remained negative. Subsequent blood examinations failed to show infection. Hence, after 20 days a test for susceptibility was performed. Both rats caught infection and died subsequently.

Experiment 6.—Horse 80. Weight 161 kilograms.

January 5, 1937.—Infected subcutaneously with surra blood.

January 11.—Blood positive (+). Temperature 37.4° C.

January 12.—Blood positive (++). Temperature 37.4° C.

January 13 to 15.—Blood positive (+ + + +). Temperature 0.4 to 1.2° C. above normal. Animal slightly dull; appetite good.

January 16 and 17.—Blood positive (+ + +). Temperature returned to normal. Animal dyspnœic, with slight œdema of hind legs.

January 18 and 19.—Blood positive (+ + + +). Temperature 38.1° C. and 39° C., respectively. Condition about same as above; appetite fair.

January 20.—Blood positive (+ +). Temperature 37.4° C.

January 21 and 22.—Blood positive (+ + +). Temperature 38.5° C. and 36.7°C., respectively.

January 23.—Blood positive (+ + + +). Temperature 38.3° C.

January 24.—Blood positive (+ +). Temperature 38.3° C. Animal reweighed (160 kilograms).

January 25.—Blood positive (+ + + +). Temperature 38.9° C.

January 26 and 27.—Blood positive (+ + +). Temperature 38.9° C. and 38.5° C., respectively. Œdema of prepuce noted for first time; appetite good.

January 28.—Blood positive (+ + + +). Temperature returned to normal. Animal dull; œdema extended to penis; anus relaxed; appetite good. Treated in the morning with 3.2 grams of each of atoxyl and naganol in 5 and 10 per cent sterile water solution, respectively, and injected intravenously. In the afternoon the horse was given hypodermically ⅓ grain strychnine sulphate in 2 cc sterile distilled water.

January 29.—Blood negative. Temperature 38.3° C. Animal depressed, with head held low. Face swollen with œdema of muzzle. Œdematous swelling of external genital organs and limbs decidedly more severe than previously; appetite remaining good. Strychnine injection repeated.

January 30 to February 14.—Blood negative. Temperature range between 35.7 and 37.7°C. Œdema previously noted in various parts of body partially subsided.

February 15.—Blood negative. Temperature 36.8° C. Appetite good; complement-fixation test negative in two tubes.

February 16 to March 1.—Blood negative. No decided improvement inspite of good appetite.

March 2.—Blood negative. Temperature 36.3° C. Complement-fixation test repeated with negative result.

March 3 to 16.—Blood negative. Condition about the same.

March 17.—Blood negative. Complement-fixation test negative in two tubes.

March 18 to May 3.—Blood negative. Temperature variable, ranging between 36.1 and 38.1° C. Condition fair.

May 4.—Blood negative. Temperature 39°C.

May 5.—Blood positive (+). Relapsed since treatment was given 108 days ago. Temperature 40°C. Infected two white mice with the blood.

May 6.—Blood negative. Temperature returned to normal. Reweighed (142 kilograms). Condition poor.

May 7.—Blood positive (+). Temperature 36.9°C.

May 8.—Blood positive (+). Temperature 37.2° C. Mice positive (+ + +), died after three days. Since the recovered trypanosomes showed no indication of lowered virulence, the horse was killed.

Experiment 7.—Horse 81. Weight 128 kilograms.

April 22, 1937.—Infected subcutaneously with surra trypanosomes.

April 30.—Blood positive (+). Temperature 39.8°C. Appetite good.

May 1.—Blood positive (+ +). Temperature 40.3° C. Condition good; appetite fair.

May 2.—Blood positive (+ +). Temperature 38.3° C. Beyond a slight dullness condition about same as above.

May 3.—Blood positive (+ + + +). Temperature 40.5°C.

May 4.—Blood positive (+ + + +). Temperature 38.5°C.

May 5.—Blood negative. Temperature 38.7°C.

May 6.—Blood positive (+). Temperature 38.8°C.

May 7.—Blood positive (+ + +). Temperature 38.8° C.

May 8.—Blood positive (+ + +). Temperature 38.4° C.

May 9 and 10.—Blood positive (+ +). Temperature 39.8°C. and 39.4°C.

May 11.—Blood positive (+). Temperature 38.6° C.

May 12.—Blood positive (+ +). Temperature 40.2°C.

May 13.—Blood positive (+ + +). Temperature 39.6°C. Blood obtained for complement-fixation test; result plus or minus (±) in each test tube; blood watery.

May 14.—Blood positive (+ + + +). Temperature 39°C. Animal reweighed (110 kilograms). Treated intraveneously with atoxyl and naganol in doses of 2.2 grams each, in same concentration as in foregoing experiments.

May 15.—Blood negative. Temperature 39.3°C. Animal depressed, weak, with œdema of face, muzzle, and legs as noted in other experimental animals.

May 16.—Blood negative. Temperature 39.4°C. Appetite good; condition unchanged.

May 17.—Blood negative. Temperature 39° C. Condition unchanged.

May 18.—Blood negative. Temperature 38.7°C.

May 19 to 25.—Blood negative. Temperature returned to normal; general condition on the decline.

May 26.—Blood negative. Temperature 35.3°C. Weakness of hind legs; perirectal eruption developed. Complement-fixation test (+) in two tubes.

May 27.—Blood negative. Temperature 38.3°C.

May 28.—Blood negative. Temperature 36.5°C. Animal down but when helped regained its legs; weakness of hind quarters quite marked. Given 2 cc fluid extract of nux vomica in water *per os.*

May 29.—Blood negative. Temperature 37°C. Early in the morning, horse noted lying down. Able to stand up if assisted. Nux vomica treatment repeated.

May 30 and 31.—Blood negative. Temperature normal. Treatment with nux vomica repeated.

June 1.—Blood negative. Temperature 38.2°C. Treatment with nux vomica with 10 cc of aromatic spirit of ammonia in water given *per os.* No improvement in condition. Results of complement-fixation test same as on two previous occasions.

June 2 to 7.—Blood negative. Temperature normal. Treatment with nux vomica and aromatic spirit of ammonia continued. Inspite of good appetite, emaciation progressing.

June 8 to 10.—Blood negative; condition unchanged.

June 11.—Blood negative. Temperature 37.2°C. 50 cc of cerebrospinal fluid obtained by means of intrathecal puncture. 40 cc was injected intraperitoneally into 4 white mice, each mouse receiving 10 cc. Balance subjected to complement-fixation test, result (+) in one tube and (+ +) in the other.

June 15.—Animal died greatly emaciated; blood of mice negative to tail-blood examination.

June 21 to 30.—Blood of mice still negative.

July 1.—Susceptiblity test performed on mice; all caught the disease 4 days after infection and died later.

THE TREATMENT OF EQUINE SURRA WITH SIMULTANEOUS INJECTION OF NAGANOL AND SODIUM ANTIMONY TARTRATE

Experiments 8 to 16 were designed to test the value of the combined trypanocidal action of naganol and sodium antimony tartrate in experimental and natural surra among native horses.

Experiment 8.—Horse 82. Weight 154.5 kilograms.

July 21, 1937.—Infected subcutaneously with surra blood.

July 29.—Blood positive (+). Temperature 38.8°C.

July 30 to August 4.—Blood positive (+ +). Temperature ranging between 38°C. and 40°C. Animal slightly dull.

August 5 to 7.—Blood negative. Temperature never above normal; slight emaciation developing; appetite good; hind quarter slightly wobbly.

August 8.—Blood positive (+ + +). Temperature 39.4°C. Condition unchanged.

August 9.—Blood positive (+ + + +). Temperature 38.7°C.

August 10.—Blood positive (+ + +). Temperature 38.8°C.

August 11.—Blood positive (+ +). Temperature 38.8°C.

August 12.—Blood positive (+). Temperature 38.3°C. Animal reweighed (138 kilograms).

August 13.—Blood positive (+ + + +). Temperature 39°C. Inspite of fair appetite animal getting more depressed and weaker.

August 14.—Blood positive (+ + + +). Temperature unchanged.

August 15.—Blood positive (+ + + +). Temperature 37.7°C. Reweighed (138 kilograms). Given intravenously 1.43 grams of sodium antimony tartrate in 1 per cent concentration and 2.76 grams naganol in 10 per cent solution. During injection of former the horse collapsed. When sufficiently recovered, the naganol was administered intravenously.

August 16.—Animal found dead in the morning.

Experiment 9.—Horse 83. Weight 111.8 kilograms.

August 15, 1937.—Inoculated with surra blood from horse 82.

August 22.—Blood positive (+). Temperature 39.2°C.

August 23.—Blood positive (+). Temperature 41°C.

August 24.—Blood positive (+). Temperature 39°C.

August 25 and 26.—Blood positive (+ +). Temperature 39.2°C. and 39.7°C., respectively. Appetite good.

August 27.—Blood positive (+ + +). Temperature 39.3°C. Animal slightly depressed.

August 28.—Blood positive (+ +). Temperature 38°C. Horse dull and slightly weak, with certain degree of emaciation; appetite fair.

August 29.—Blood positive (+), watery. Temperature 38.2°C.; condition same as above.

August 30.—Blood positive (+ +). Temperature 38.2°C.

August 31.—Blood positive (+ +). Temperature 39.9°C.

September 1.—Blood positive (+ + +). Temperature 40.9°C.

September 2.—Blood positive (+ +). Temperature 39.6°C.

September 3.—Blood negative. Temperature 37.6°C.

September 4.—Blood positive (+). Temperature 39.5°C.

September 5.—Blood positive (+ +). Temperature 39.4°C.

September 6.—Blood positive (+ + + +). Temperature 39.4°C. Reweighed (87 kilograms). Treated with 1.74 grams of naganol and 0.65 grams of sodium-antimony tartrate. During the naganol injection the respiration was 30, but when the antimony was given it rose to 60 per minute.

September 7.—Blood negative. Temperature 40.2°C.; respiration normal.

September 8.—Blood negative. Temperature 38.7°C. Appetite poor; animal weak and decidedly depressed.

September 9.—Blood negative. Temperature 38.7°C. Œdema of the hind legs; streaks of blood noted in the anal region.

September 10.—Animal found dead the following morning.

Experiment 10.—Horse 84. Weight 162 kilograms.

August 15, 1937.—Infected with surra blood from animal 83.

August 22.—Blood negative. Temperature 40.5°C. Animal slightly dull but appetite good.

August 23.—Blood positive (+). Temperature 39°C.

August 24.—Blood positive (+). Temperature 38.3°C.

August 25.—Blood positive (+ +). Temperature 40.6°C.

August 26 and 27.—Blood negative. Temperature normal.

August 28.—Blood positive (+ +). Temperature same as above.

August 29.—Blood positive (+ +). Temperature 38.9°C.

August 30.—Blood positive (+). Temperature 39.1°C.

August 31.—Blood negative. Temperature 37.1°C.

September 1.—Blood positive (+ +). Temperature 40.6°C.

September 2.—Blood positive (+). Temperature 40.9°C.

September 3.—Blood negative. Temperature 41°C.

September 4.—Blood negative. Temperature 40.4°C.

September 5.—Blood negative. Temperature 39°C. Animal reweighed (174 kilograms). Treated with 2.58 grams of naganol and 1.3 grams of sodium antimony tartrate.

September 6.—Blood negative. Temperature 38°C. Animal decidedly depressed with œdema of pendant portion of body.

September 7.—Blood negative. Temperature 37.5°C. Condition same as above.

September 8 to 17.—Blood positive. Temperature never above 38.1°C.; condition slightly improved.

September 18.—Blood negative. Temperature 37.8°C. Animal improving, treatment with naganol-sodium antimony tartrate repeated.

September 19.—Blood negative. Temperature 38.1°C.

September 22.—Horse found dead.

Experiment 11.—Horse 85. Weight 163 kilograms; a greatly emaciated animal.

November 13, 1937.—Injected subcutaneously with 10 cc of blood from a surra carabao.

November 24.—Blood positive (+). Temperature 39.1°C.

November 25.—Blood positive (+ +). Temperature 38.8°C.

November 26.—Blood positive (+ + +). Temperature 39° C.

November 27.—Blood positive (+ + +). Temperature 38.9°C.

November 28.—Blood positive (+ + + +). Temperature 39.5°C.

November 29.—Blood positive (+ +). Temperature 38°C.

November 30.—Blood positive (+). Temperature 39°C. Appetite fair; emaciation more marked with bilateral nasal discharge.

December 1.—Blood positive (+). Temperature 38.9°C.

December 2.—Blood positive (+). Temperature 38.2°C. Appetite poor; animal decidedly weak.

December 3.—Animal found dead; no autopsy performed.

Experiment 12.—Horse 86. Weight 140 kilograms.

October 11, 1937.—Infected with surra blood from a rat.

October 17.—Blood positive (+). Temperature 37.6°C.

October 18.—Blood positive (+ +). Temperature 38.5°C.

October 19.—Blood positive (+ + + +). Temperature 38.6° C.

October 20 and 21.—Blood positive (+ + + +). Temperature 38.7°C. and 39.2° C.

October 22.—Blood positive (+ + +). Temperature 38.6°C.

October 23.—Blood negative. Temperature 37.2°C.

October 24.—Blood positive (+). Temperature 37.8°C.

October 25.—Blood positive (+). Temperature 37.2°C.

October 26.—Blood positive (+ +). Temperature 38.7°C.

October 27.—Blood positive (+). Temperature 37.4°C.

October 28.—Blood positive (+ + + +). Temperature 39.2°C.

October 29.—Blood positive (+). Temperature 37.9°C.

October 30.—Blood positive (+ +). Temperature 37.9°C. Animal reweighed (134 kilograms). Treated with 2 grams naganol in 10 per cent solution in the morning, and in the afternoon the animal was injected with 1 gram of sodium-antimony tartrate in 1 per cent concentration.

October 31.—Blood negative. Temperature 38.9°C.

November 1.—Blood negative. Temperature 40°C.

November 2.—Blood negative. Temperature 38.9°C.

November 3 to December 7.—Blood negative. Temperature ranging between 36.5°C. and 38.4°C.

December 8.—Blood negative. Temperature 39.9°C. Complement-fixation test negative in one tube and (+) in the other.

December 9 to 30.—Blood negative. Temperature never over 38.4°C.

December 31.—Blood negative. Temperature 38°C. Complement-fixation test (+ +) in first (+ + +) in second tube.

January 3 to February 1, 1938.—Blood negative. Temperature normal. Animal decidedly improved.

February 2.—Blood negative. Temperature 37.2°C. Complement-fixation test negative in two tubes.

February 3.—Blood negative. Temperature 37.5°C.

February 7.—Blood negative. Temperature 37°C. Due to unknown cause the horse accidentally fell into the manger. When released the animal attempted to rise on its feet but failed. Hence it was supported in a standing position with a sling. Animal treated with 0.1 grain of strychnine sulphate hypodermically.

February 8.—Blood negative. Temperature 38°C. Bruises on the back, neck, and legs treated with a liberal application of white lotion. Injection of strychnine sulphate repeated.

February 9.—Blood negative. Temperature 37.6°C. Bruises dressed same as above. Hypodermic injection of strychnine sulphate given.

February 10 to 16.—Blood negative. Temperature never above normal. Bruises treated as usual. Strychnine sulphate treatment given daily; animal much improved.

February 17 to 27.—Blood negative. Temperature never above 37.8°C. The animal kept continuously in sling. Skin lesions beginning to suppurate, treatment changed to a mixture of pine tar, glycerine, and phenol.

February 28.—Blood negative. Temperature 37.8°C. The skin lesions dressed as above. Given under the skin, 1,500 units of tetanus antitoxin.

March 1 to 8.—Blood negative. Temperature normal. Horse taken daily for a short walk. When in the stall the animal was in sling; skin lesion treated as usual. Condition decidedly improved.

March 9.—Blood negative. Temperature 37.5°C. Lesions on the skin treated in the same manner as above. Complement-fixation test negative in both tubes.

March 10 to 15.—Blood negative. Temperature ranging between 36.9°C. and 37.7°C.

March 16.—Blood negative. Temperature 38°C. Sling removed; animal placed in pasture for an hour; skin lesions almost healed.

March 17 to April 5.—Blood negative. Temperature never above 38.4° C.; animal gaining in weight.

April 6.—Blood negative. Complement-fixation test negative. Skin lesions completely healed.

April 7 to July 5.—Blood negative. Temperature normal. Animal gained considerable weight (150 kilograms).

July 6, 1938, to April 30, 1940.—Animal in excellent condition; weight 160 kilograms. Repeated animal inoculations of both cerebrospinal fluid and blood never showed surra trypanosomes.

Experiment 13.—Horse 87. Weight 145 kilograms.

January 29, 1938.—Infected subcutaneously with surra organisms obtained from a guinea pig.

February 5.—Blood positive (+ +). Temperature 40°C.

February 7.—Blood positive (+ + +). Temperature 39.4°C.

February 8.—Blood positive (+ + + +). Temperature 40.5°C. Animal slightly dull with accelerated respiration.

February 9.—Blood positive (++). Temperature 38.3°C. Dullness, but augmented respiration subsided.

February 10.—Blood positive (+). Temperature 38.5°C.

February 11.—Blood positive (+ +). Temperature 40°C.

February 12.—Blood positive (+ + +). Temperature 38.2°C.

February 14.—Blood positive (+). Temperature 37.8°C.

February 15.—Blood negative. Temperature 38.4°C.

February 16.—Blood positive (+). Temperature 38.6°C.

February 17.—Blood positive (+ + + +). Temperature 40.2°C. Animal slightly depressed with a serous bilateral nasal discharge.

February 18.—Blood positive (+ + + +). Temperature 39.2°C. Animal reweighed (141 kilograms). One male white rat inoculated with cerebrospinal fluid obtained by means of suboccipital puncture. Naganol treatment instituted in the afternoon, 2.12 grams dissolved in 40 cc sterile distilled water.

February 19.—Blood negative. Temperature same as above. Œdema formed in various parts of body, as in the muzzle, scrotum, and preputial region; animal quite depressed. In the afternoon 1.3 grams of sodium-antimony tartrate in 1 per cent solution injected intravenously.

February 20.—Sunday, no treatment given.

February 21.—Blood negative. Anal region moist and penis protruding. Œdematous swelling observed soon after naganol therapy still persisting. Inoculated rat still negative on microscopic examination of tail blood.

February 22 to 24.—Blood negative. Temperature normal. Condition unchanged.

February 25.—Blood negative. Temperature 37.2° C. Œdematous swelling subsiding; appetite good.

February 26.—Blood negative. Temperature 37.3° C. Animal quite weak but appetite good.

February 28.—Blood negative. Temperature 38° C.

March 1.—Inoculated white rat noted for the first time positive and died 3 days later.

March 2 to 28.—Blood negative. Temperature never above 38.4° C. Œdema subsided completely, even penis retracted into its sheath; animal starting to pick up. Perirectal eruption almost healed.

April 6.—Blood negative. Complement-fixation test negative in one tube but (±) in the other.

April 7 to June 21.—Blood negative. Animal noticeably improved.

June 22.—Blood negative. Complement-fixation test negative in two test tubes.

June 23 to December 31.—Animal turned into the pasture. Complement-fixation test performed in three instances all negative. Repeated laboratory animal inoculations with blood likewise negative.

January 1 to November 30, 1939.—Animal never showed sign of surra; repeated inoculation into laboratory animals of both blood and cerebrospinal fluid negative; horse reweighed (220 kilograms).

December 20, 1939.—Killed for anatomy specimen.

Experiment 14.—Horse 88. Weight 245 kilograms.

March 12, 1938.—Animal admitted to the college hospital suffering from surra. Except for slight degree of emaciation, condition fair. Blood on examination teeming with trypanosomes (+ + + +). Temperature 39° C. Given intravenously 2 grams of naganol in 10 per cent sterile distilled water. Four hours later, given 1.30 grams of sodium-antimony tartrate in 1 per cent concentration.

March 14.—Blood negative. Temperature 37.5° C.; œdema of the scrotum, prepuce, and penis noted. In fact the penis remained out of the sheath all the time (paraphimosis); appetite good.

March 15.—Blood negative. Temperature 38.2° C.; condition the same as above.

March 16.—Blood negative. Temperature 37.6° C.

March 18.—Blood negative. Temperature 38.4° C. Paraphimosis considerably improved, penis partially retracted into the sheath.

March 19.—Blood negative. Temperature 37.6° C. Œdematous swelling together with paraphimosis completely subsided. Animal decidedly improved.

March 23.—Blood negative. Temperature 38.2° C. Perirectal eruption noted which behaved in much the same manner as in previous experiments.

March 23 to April 5.—Blood negative. Temperature never above 38.4° C.

April 6.—Blood negative. Temperature 37.8° C. Complement-fixation test (+ + +) in the first and (+ + + +) in the second tube.

April 6 to 28.—Blood negative. Animal slightly emaciated.

May 1.—Blood negative. Temperature 38° C; paresis of hind legs noted for first time.

May 2.—Blood negative. Temperature 37.6° C. Appetite good. Due to paretic condition of hind quarters horse unable to remain standing, even when assistance was given.

May 3.—Animal killed *in extremis.*

Experiment 15.—Horse 89. Weight 146 kilograms.

July 2, 1938.—Admitted at the clinic of the College of Veterinary Science with the complaint of irregular appetite. Blood examination positive (+ + +) for surra. Temperature 38° C. Animal slightly depressed.

July 3.—Blood positive (+). Temperature 38.3° C. Given 2.5 grams of naganol.

July 4.—Blood negative. Temperature 39.5° C. Œdema of pendant portion of body. Given 1.3 grams of sodium-antimony tartrate.

July 5.—Blood negative. Temperature 38.8° C. Œdematous swelling slightly subsided; appetite fair.

July 6.—Blood negative. Temperature 37.5° C. Appetite good; condition decidedly improved; animal quite active.

July 7 and 8.—Blood negative. Temperature 38° C.

TABLE 1.—*Data from experiments 1 to 7, showing a summary of the results of the naganol-atoxyl treatment for equine surra.*

Experiment.	Animal.	Weight.		Infected.	Prepatent period.	Treatment.			Results.	Remarks.
		Before infection.	After infection.			Date.	Naganol.	Atoxyl.		
		Kg.	*Kg.*		*Days.*		*g.*	*g.*		
1	75	--------	175	----------------	------	March 18, 1936	1.750	2.63	Died May 4, 1936 -------	Trypanosomes never recovered; animal developed paresis during course of observation.
						March 27, 1936	0.875	2.63		
						April 6, 1936	0.875	2.63		
2	76	124.5	130	May 18, 1936	7	June 8, 1936	1.300	1.95	Died August 19, 1936 ----	Trypanosomes recovered by animal inoculation.
						June 14, 1936	0.650	2.60		
						June 20, 1936	0.650	2.60		
3	77	138.0	125	October 21, 1936	5	November 9, 1936	2.500	2.50	Died September 5, 1937, 294 days after treatment.	Developed paresis of hind quarters.
4	78	117.0	105	November 18, 1936	11	December 10, 1936	2.100	2.10	Died December 16, 1936 --	Paresis developed at time treatment was given and continued up to death.
5	79	102.0	92	December 17, 1936	8	December 30, 1936	1.800	1.80	Died February 1, 1937 ---	Developed weakness of hind legs; organisms never recovered.
6	80	161.0	160	January 5, 1936	7	January 28, 1937	3.200	3.20	Relapsed May 5, 1937; killed later.	Trypanosomes noted in blood after treatment; animal inoculation showed that virulence was not altered by the drugs.
7	81	128.0	110	April 22, 1937	9	May 14, 1937	2.200	2.20	Died June 15, 1937 ------	Trypanosomes never recovered; developed weakness of hind quarters.

TABLE 2.—*Data from experiments 8 to 16, showing a summary of the results of the naganol-sodium-antimony tartrate treatment against equine surra.*

Experiment.	Animal.	Weight.		Infected.	Prepatent period.	Treatment.			Results.	Remarks.
		Before infection.	After infection.			Date.	Naganol.	Sodium-antimony tartrate.		
		Kg.	*Kg.*		*Days.*		*g.*	*g.*		
8	82	154.5	138	July 21, 1937	9	August 15, 1937	2.76	1.43	Died August 16, 1937	Collapsed during the injection of sodium-antimony tartrate.
9	83	111.8	87	August 15, 1937	8	September 6, 1937	1.74	0.65	Died September 11, 1937	
10	84	162.0	174	do	9	September 5, 1937	2.58	1.30	Died September 22, 1937	Animal improving during second injection.
						September 18, 1937	2.58	1.30		
11	85	163.0		November 13, 1937	12				Died December 3, 1937	Horse died due to emaciation before treatment was instituted.
12	86	140.0	134	October 11, 1937	7	October 30, 1937	2.00	1.00	Animal still living at present writing.	Increased in weight (to 160 kilograms) and in excellent condition.
13	87	143.0	141	January 29, 1938	8	February 18, 1938	2.12		Animal recovered; killed December 20, 1939.	Increased in weight (220 kilograms); complement-fixation test negative.
						February 19, 1938		1.30		
14	88		245			March 12, 1938	2.00	1.30	Killed *in extremis* May 3, 1938.	Developed paresis of hind legs.
15	89		146			July 3, 1938	2.50		Animal recovered	After about a year of observation, horse cannot be located.
						July 4, 1938		1.30		
16	90		216			July 3, 1938	3.00		Died July 12, 1938	Autopsy revealed double pneumonia.
						July 4, 1938		1.30		

July 9.—Blood negative. Temperature 37.7° C. Œdema which developed after naganol injection completely disappeared.

July 10.—Blood negative. Temperature 37.5° C.

July 14.—Blood negative. Temperature 38.1° C. Complement-fixation test (+ +) in the first and (+ + +) in the second tube.

July 15.—Blood negative. Temperature 38° C. Since the general condition of the animal had decidedly improved, it was delivered to the owner and placed under observation. After about a year had elapsed neither the horse nor the owner could be located.

Experiment 16.—Horse 90. Weight 216 kilograms.

July 3, 1938.—Received in the clinic of the College of Veterinary Science with the complaint of anorexia and general debility. Blood positive (+ +) for surra trypanosomes. Given 3 grams of naganol intravenously in 10 per cent concentration.

July 4.—Blood negative. Temperature 39.9° C. Œdematous swellings noted same as in above experiment. Given 1.3 grams of sodium antimony tartrate.

July 5.—Blood negative. Temperature 40° C. Animal quite depressed with poor appetite. Head carried low. Given hypodermically ⅛ grain of strychnine sulphate in 4 cc of sterile distilled water.

July 6.—Blood negative. Temperature 39.3° C. Appetite slightly improved. Strychnine injection repeated.

July 7.—Blool negative. Temperature 38.7° C. Treated with strychnine sulphate.

July 8.—Blood negative. Temperature 38.4° C. Strychnine sulphate given.

July 9.—Blood negative. Temperature 40.3° C. Appetite poor; animal dull.

July 10.—Blood negative. Temperature 38.5° C. Animal depressed, with marked pneumonic symptoms.

July 11.—Blood negative. Temperature 40° C. Condition unchanged.

July 12.—Animal found dead in the morning. Autopsy revealed both lungs badly hepatized.

For the sake of clarity some of the results of the experiments were condensed and are given in Tables 1 and 2.

THE TREATMENT OF BORNEO HORSES NATURALLY INFECTED WITH SURRA WITH SIMULTANEOUS INJECTIONS OF NAGANOL AND SODIUM-ANTIMONY TARTRATE

Experiment 17.—Because of the encouraging results obtained with the simultaneous treatment of naganol and sodium-antimony tartrate in artificially and naturally infected horses in the Islands, this treatment was tried with the field cases of surra among horses encountered in the British North Borneo (chartered) Company at the time (summer of 1938) the author was detailed in that territory.

The principal vector in this outbreak of surra was a brown horsefly which answered closely the description of *Tabanus fumifer* Walker.[3]

The following is a summary of the clinical manifestations observed in these animals. During the early stage of the disease practically no clinical manifestations were visible, save a variable appetite and intermittent fever. In the course of time progressive emaciation developed. There were periods when the animal was depressed and lethargic and showed accelerated respiration and an augmented heart beat. The jugular vein pulse in some cases was decidedly prominent. The mucous membrane was either injected, icteric, or pale, the last being noticeable during the last stage of the disease. Urticaria was an occasional symptom. Œdema of the pendant portions of the body was noted in protracted cases, although not usually prominent. During the course of the disease some of the animals appeared to improve and the symptoms seemed to subside, only to give way to alarming manifestations later. In the last stage of the disease the gait was observed to be unsteady (off their feet) with a decided knuckling of the fetlocks, indicative of nervous complications. Toward the end the animal was not able to maintain a standing position. A case was noted in the course of this investigation where the pony developed convulsions and coma before death.

While in Kudat district 10 horses were noted positive for surra, in Kota Belud district 92 animals were noted. Most of these positive horses showed no clinical symptoms of the disease. The presence of the causative agent in the blood revealed by microscopic examination of the moist blood preparation was the only indication of the disease in question. In other words, the majority of cases were in the first stage of the disease. Since all the infested animals in Kudat district were mature horses, they were each given a simultaneous injection of naganol and sodium-antimony tartrate in doses of 2 grams and 1.3 grams, respectively. Out of the 10 treated animals only 2 survived, according to a letter received June 19, 1939, after over a year of observation. In Kota Belud district 90 of the 92 surra-positive individuals were actually given the naganol-sodium-antimony treatment; 2 other horses were killed due to the advanced condition of the disease. Observing that the horses treated showed no alarming signs of drug intoxication the doses of the drugs for the adult horses were increased up to 3 grams for naganol and 1.5 grams of sodium-antimony tartrate. This increased dosage was especially indicated in those individuals that were in good condition and showing no indication of the disease except a positive microscopic examination of the blood. For animals about 1 year old the dose was reduced to 1 gram naganol and 0.5 gram sodium-antimony tartrate. Of the 90 treated animals, 61 were still living after observation for 405 days.[4]

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[3] Determined by Dr. Alan Stone, Associate Entomologist, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

All of the animals treated showed symptoms of naganol poisoning in the form of periproctitis, which disappeared in about 20 days. In some cases which showed œdema of the pendant portion of the abdomen at the time of medication, this symptom was aggravated on treatment but later subsided completely. It was reported that those which failed to respond favorably to the treatment showed nervous complications mainly in the form of paresis of the hind quarters before death.

DISCUSSION

Treatment of equine surra with simultaneous injection of naganol and atoxyl.—Although the terminal result of each of the horses used in experiments 1 to 7 was death, horse 77 in experiment 3 showed indications of apparent recovery at least in terms of the length of time the animal survived after treatment was given. In this case the horse lived approximately 10 months. Further, the infecting organism was recovered from the animal neither by repeated blood examination nor by laboratory animal inoculations. On the other hand, the results of the complement-fixation tests performed at various times during the observation period fluctuated time and again. There was a time when it was negative (June 5, 1936) but it became positive before the animal died. The weakness of the hind legs which developed during the last days of its life suggests that nervous complications had set in. In horses 76 and 80 the organisms were recovered; in the former by animal inoculation and in the later by both microscopic examination of the blood and animal inoculation. While horses 75 and 76 were given fractional doses spread over a period of 21 days, horses 77 to 81 were given simultaneous single large doses. The results obtained in each group show no significant difference. Lastly, the results recorded in experiments 1 to 7, in connection with the giving of naganol and atoxyl in subtoxic doses as a treatment against surra, do not support the findings of Bubberman, Douwes, van Bergen, and Zijp and Bubberman in the Dutch East Indies, who recorded satisfactory results in the treatment of the disease. These contradictory results may be attributed to a difference in virulence between the strain of trypanosome used in the above series of experiments and that used in the Dutch East Indies, as well as to the stage of the disease when treatment was instituted.

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[4] Thanks are extended to Mr. W. G. Higgins, district agricultural officer, and his assistant, Mr. J. Leaño, for furnishing me a report on the final result of the treatment of surra in British North Borneo.

Treatment of equine surra with simultaneous injection of naganol and sodium-antimony tartrate.—Of the five experimentally infected native horses subsequently treated with a combined injection of naganol and sodium-antimony tartrate, 2 recovered from surra infection (Horses 86 and 87). While horse 86 is still living at the present writing, in excellent condition and without trace of the disease, horse 87 was also in good health when killed for anatomy specimen after approximately 1 year and 10 months posttreatment observation. The three other animals died as a result of drug intoxication (horses 82, 83, and 84). Of the three horses that succumbed as a result of the treatment one animal (horse 82) collapsed shortly after the injection of sodium-antimony tartrate. In view of this untoward result, in experiments performed later naganol was injected first and the sodium-antimony salt last. In fact, when the condition of the animal was weakened considerably as a result of the disease, the second injection was administered the day following. Incidentally, the above observation finds a certain amount of support in the findings of Edwards(5) on the use of tartar emetic as a trypanocidal agent. In some of the cases of this worker injection of tartar emetic was followed by drastic results, even sudden death. This investigator attributed this untoward effect to either the occlusion of the blood capillaries or the liberation of toxic substances from the dead trypanosomes. The results obtained in horse 84 suggest that the simultaneous injection of naganol and sodium antimony tartrate should not be repeated within 13 days after the first treatment. Horse 85 died before treatment was given due mainly to the emaciated condition at the time of infection, and hence must be considered a poor risk. Of the three naturally infected horses one recovered, one was killed, and the third died (Table 2). Failure to effect recovery in horse 88 was principally due to comparatively small doses of the drugs. Horse 90 died 9 days after the second injection, not as a result of the direct toxic effects of the drugs but due to a complicating double pneumonia.

The results obtained in both artificially and naturally infected surra animals in experiments 8 to 16, where 3 out of 9 horses recovered from the disease, warrant the statement that naganol-sodium-antimony tartrate is decidedly better than the naganol and atoxyl combination. Moreover, the present findings are in agreement with those of C. Kahan Singh in India, Bakker in the Netherland Indies, and Topacio in the Philippines.

Treatment of equine surra in British North Borneo with the naganol-sodium-antimony-tartrate therapy.—Reference to experiment 17 conducted in British North Borneo at the time the writer was engaged in the control of surra in that territory furnished further data supporting the efficacy of the treatment above discussed. In Kudat district, of the 10 horses treated 2 were reported living after over a year of observation. On the other hand, in Kota Belud district out of 90 surra-positive animals subjected to naganol-sodium-antimony tartrate therapy 61 were still alive after a lapse of more than one year posttreatment observation. In view of the disparity in the number of the treated surra animals in the two districts, a comparative study of the significant difference in the result of the treatment seems useless. However, the high mortality in the Kudat district and the great number of recoveries in the district of Kota Belud may be attributed (*a*) to the fact that the doses given the horses in Kudat were comparatively smaller than those given in Kota Belud district (while the dose administered in the former among adult individuals was 2 grams and 1.3 grams of naganol and sodium-antimony tartrate, respectively, in Kota Belud the dose was 3 grams of naganol and 1.5 grams of the antimony salt); (*b*) as the disease was first observed in Kudat, it is not unlikely that most of the surra treated animals were in a more advanced state than those of Kota Belud in general, although the manifestations did not show it.

Summing up all cases treated, 100 horses were given the naganol-sodium-antimony tartrate combinations. Of this number, 63 animals recovered from the disease. In terms of percentage a recovery of 63 per cent is attained as a result of the drug intervention.

SUMMARY AND CONCLUSIONS

Experiments designed to test the relative value of the naganol and atoxyl combination against naganol-sodium antimony tartrate therapy in the treatment of equine surra were performed.

It has been found that naganol-atoxyl therapy, beyond prolonging the course of the disease, is valueless as a treatment of surra. On the other hand, when naganol is combined with sodium-antimony tartrate and administered in nonlethal but slightly toxic doses, two out of five artificially infected surra horses and one out of three naturally infected animals recovered from the disease. Furthermore, from the field trial carried out in British North Borneo during the summer of 1938, of the 100 horses naturally infected and actually given the naganol sodium-antimony-tartrate combination, 63 were cured of surra.

The above results lead to the conclusion that the naganol-sodium-antimony-tartrate therapy is superior to the naganol and atoxyl combination in the chemotherapy of equine surra.

LITERATURE CITED

1. BAKKER, S. Een en ander over surra in den ambtskring Padang Sidempoean. Ned. Ind. Bladen v. Diergeneesk. en Dierenteelt **37** (1925) 153–177. Summarized by Andrews in Trop. Vet. Bull. **13** (1925) 76, 78.
2. BAKKER, S. Over de surra en hare bestrijding in Nederlandsch Indie. Tijdschr. Diergeneesk. **59** (1932) 19–32. Summarized by Sheather in Vet. Bull. **2** (1932) 544.
3. BUBBERMAN, C. The control of trypanosomiasis in the Dutch Indies. Eleventh International Veterinary Congress. London (1930) 1–8. English translation from the original by S. Youngberg.
4. BUBBERMAN, C., J. B. DOUWES, and V. E. C. VAN BERGEN. Over de toepassing van "Bayer 205" bij de surra van het paard in Nederlandsch-Indie. Veeartsenijkundige Mededeeling en Depart. v. Landbouw, Nijverheid en Handel, Buitenzorg. No. 50 (1925) 64. Summarized by Andrews in Trop. Vet. Bull. **13** (1925) 73–76.
5. EDWARDS, J. P. The chemotherapy of surra of horses and cattle in India. Journ. Compar. Path. and Therapeutics **39** (1926) 83–119, 169-201.
6. HORNBY. Control of animal trypanosomiasis. Eleventh International Veterinary Congress. London **3** (1931) 614–631. Cited by Sen in Ind. Journ. Vet. Sci. and Anim. Husb. **3** (1933) 85–102.
7. KAHAN, SINGH C. Report of the Work Performed by the Office in Charge of the Camel Specialist Office, Sohowa, for the year 1927–1928.

8. TOPACIO, TEODULO. Studies on surra. I. The F. N. T. E. treatment of native horses in experimental infection; II. The F. N. T. E., treatment of native horses in natural infection. Philip. Journ. Ani. Ind. 5 (1938) 605–610. Results rectified by Generoso in a personal communication, 1939.

9. YUTUC, LOPE M. Experimental studies on the curative treatment of surra in native horses in the Philippines. I. Philip. Journ. Sci. 54 (1934) 9–27.

10. YUTUC, LOPE M. Experimental studies on the curative treatment of surra in native horses in the Philippines. II. Philip. Journ. Sci. 61 (1936) 401–414.

11. YUTUC, LOPE M. A report on the first outbreak of surra in British North Borneo and its control measure. Philip. Journ. Anim. Ind. 5 (1938) 501–515.

12. ZIJP, P. Waarde van de therapeutische aanwending van naganol en atoxyl tegen surra bij het paard mode in verband met de wettelijke bestrijding dierzieke. Nederl.-Indisch. Bladen v. Diergeneesk. 41 (1929) 239–252. Summarized in Trop. Vet. Bull. 17 (1927) 112.

TREMATODE PARASITES OF PHILIPPINE VERTEBRATES, IX

FLUKES FROM THE DOMESTIC FOWL AND OTHER BIRDS

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THREE PLATES

Family NOTOCOTYLIDÆ Luehe, 1909

NOTOCOTYLUS INTESTINALIS Tubangui, 1932.

A single specimen of this parasite was found in the intestinal contents of a native chicken. This trematode was originally described by Tubangui(16) from the intestine of a domestic duck.

Host.—*Gallus gallus domesticus.*

Location.—Intestine.

Locality.—Manila? Philippines.

Family EUCOTYLIDÆ Skrjabin, 1924

TAMERLANIA BRAGAI Dos Santos, 1934. Plate 2, fig. 1.

This trematode is also represented by a single specimen found in sedimented material prepared from the intestinal contents of a domestic pigeon. Since the normal habitat of flukes of this type is the urinary tract, it may be assumed that the worm escaped from one of the kidneys or ureters of the host during dissection and became mixed with the intestinal contents. Compared with the members of the genus *Tamerlania* Skrjabin as listed by Penner (1935) it shows great similarity to *T. bragai* Dos Santos (1934), a parasite of pigeons and chickens in Brazil.

Description.—Body 2.5 by 0.4 millimeters. Cuticle armed with numerous small spines. Oral sucker 0.2 millimeter across; pharynx 0.08 by 0.1 millimeter; œsophagus absent; intestinal cæca uniting immediately behind posterior level of vitellaria.

Testes small, oval, symmetrical, immediately postovarial, in middle of second fourth of body length, 0.12 to 0.14 by 0.09 to 0.11 millimeter. Seminal vesicle anterior to and partly overlapped by ovary. Genital pore not seen.

Ovary multilobular, larger than either testis. Vitellaria mostly extracæcal, extending from immediately behind level of intestinal fork to junction of middle and last thirds of body length. Uterus very well developed, its coils filling up most of space behind intestinal fork. Eggs 30 to 33 by 12 to 13 microns.

Host.—Domestic pigeon.

Location.—Kidney.

Locality.—Manila? Philippines.

Family PLAGIORCHIIDÆ Luehe, 1901

PROSTHOGONIMUS PSEUDOPELLUCIDUS sp. nov. Plate 1, figs. 1 and 2.

Numerous specimens of this fluke were collected from the bursa Fabricii of native chickens purchased from the different markets in Manila. More than 200 birds were examined during May and June, 1940, and of these about 8 per cent were found harboring the parasite. We were unable to determine the exact origin of the hosts due to the fact that the chickens sold in Manila come from different localities in the Islands.

Description.—Body ovate, 4.2 to 5.3 by 1.9 to 3.6 millimeters. Cuticle armed with small spines. Oral sucker subterminal, 0.3 to 0.5 millimeter across; acetabulum 0.4 to 0.6 millimeter in diameter, between anterior and middle thirds of body length. Average sucker ratio 1 to 1.2. Prepharynx very short; pharynx 0.10 to 0.13 by 0.13 to 0.17 millimeter; œsophagus 0.18 to 0.29 millimeter long; intestinal cæca reaching posteriorly to level midway between posterior border of testes and posterior end of body or slightly behind that level.

Testes symmetrical, entire, oval, postovarial, at or near middle of body length, 0.42 to 0.64 by 0.29 to 0.37 millimeter. Cirrus pouch elongated, slightly coiled, 0.9 to 1.1 by 0.06 to 0.08 millimeters, extending posteriorly to or a little beyond intestinal bifurcation and inclosing the long seminal vesicle, poorly developed prostate, and short cirrus. Genital pore at anterior end of body, lateral to oral sucker.

Ovary lobulated, with 11 to 25 clustered lobes, 0.4 to 0.5 by 0.5 to 0.58 millimeter, immediately behind and partly overlapped by acetabulum and slightly to one side of median line. Ootype complex, adjacent to posteromedial border of ovary; shell gland very prominent, receptaculum seminis and Laurer's canal present. Uterus loosely coiled, at posterior half of body length, behind ovary and testes; no uterine coils in front of acetabulum. Vitelline follicles tend to be arranged in clusters, of which there are 7 or 8 on the left side and 9 to 12 on the right side; they extend from a little in front of the anterior level of the acetabulum to the level of the testes or more posteriorly. Eggs oval, yellowish, operculated, 22 to 24 by 13 to 13.5 microns, with spine at aboperculated end.

Excretory pore posteroterminal. Excretory bladder characteristically Y-shaped.

Host.—*Gallus gallus domesticus.*

Location.—Bursa Fabricii.

Locality.—Manila? Philippines.

Type specimens.—Philippine Bureau of Science parasitological collection No. 602.

Of the previously described species in the genus *Prosthogonimus* listed by Macy(9) and Witenberg(21) the parasite from the Philippine chicken resembles only *P. pellucidus* in having the acetabulum as large as or only insignificantly larger than the oral sucker. In the other members of the genus the acetabulum is at least two-and-a-half times the size of the oral sucker. *Prosthogonimus pseudopellucidus* may, however, be distinguished from its near relative by the smaller size of the eggs, the equatorial position of the testes, and the extent of the intestinal cæca and vitellaria, the latter reaching anteriorly beyond the level of the anterior border of the acetabulum. In *Prosthogonimus pellucidus* the vitellaria do not reach anteriorly beyond the level of the posterior border of the acetabulum, the testes lie behind the middle of the body length, and the intestinal cæca extend to near the posterior end of the body.

PROSTHOGONIMUS CUNEATUS (Rudolphi, 1809). Plate 1, fig. 3.

A single specimen of this trematode, measuring 3.8 by 1.7 millimeters, was obtained from a chicken. It agrees with the description of *Prosthogonimus cuneatus* (Rudolphi, 1809), as given by Braun,(2) except that it is smaller and its vitellaria extend more towards the anterior end of the body and show a tendency to form clusters.

Host.—*Gallus gallus domesticus.*

Location.—Bursa Fabricii.

Locality.—Manila?, Philippines.

Family ECHINOSTOMATIDÆ Looss, 1902

ECHINOSTOMA REVOLUTUM (Froelich, 1802).

This trematode has been reported by Tubangui(16) from the Philippine domestic duck and experimental pigeons. The same writer also determined that the parasite utilizes the snail, *Lymnæa* (*Radix*) *swinhoe* var. *quadrasi* von Moellendorff,[1] as primary and secondary intermediate host.

Host.—*Gallus gallus domesticus.*

Location.—Intestine.

Locality.—Manila?, Philippines.

EPISTHMIUM GALLINUM sp. nov. Plate 3, fig. 1.

A single specimen of this trematode was found in the bursa Fabricii of a chicken. It is apparently a very rare parasite of chickens, for we have made repeated attempts to secure additional material with negative results.

Description.—Body 1.1 by 0.4 millimeters; dorsal surface up to level of anterior border of acetabulum and ventral surface to level of second testis covered sparsely with spines. Oral sucker subterminal, 0.1 millimeter in diameter; acetabulum equatorial, 0.13 millimeter across. Cephalic collar vestigial, 0.17 millimeter across; collar spines, of which only four are visible on each side, poorly developed, 15 microns long, only slightly larger than body spines. Prepharynx very short; pharynx 0.08 by 0.09 millimeter; œsophagus 0.17 millimeter long; intestinal cæca reaching to near posterior end of body.

Testes postovarial, in middle of last third of body length, one immediately and obliquely behind the other; anterior testis median, more or less circular in outline, 0.16 millimeter in diameter; posterior testis displaced to right side of median line, oval, 0.16 by 0.1 millimeter. Cirrus sac small, pyriform, 0.08 by 0.07 millimeter, on right side of median line, immediately in front of acetabulum and inclosing small seminal vesicle, poorly developed pars prostatica, and short cirrus. Genital pore median, about midway between intestinal fork and anterior border of acetabulum.

Ovary small, subglobular, 0.09 by 0.08 millimeter, to right side of median line, about midway between acetabulum and first testis. Shell gland very profuse, between ovary and anterior testis, stretching transversely from one inner cæcal wall to the other. Uterus short, with few (2) eggs. Vitellaria moderately developed, mostly extracæcal, extending from immediately in front of level of œsophageal bifurcation to posterior end of body;

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[1] According to the nomenclature used by Bequaert and Clench(1) for Philippine lymnæid snails, this should be the name of the mollusc which was designated by Tubangui (1932) as *Lymnæa peregra* (Mueller).

they meet anteriorly and posteriorly. Eggs oval, yellowish, operculated, 82 to 98 by 49 to 56 microns.

Host.—*Gallus gallus domesticus.*

Location.—Bursa Fabricii.

Locality.—Manila?, Philippines.

Type specimen.—Philippine Bureau of Science parasitological collection No. 605.

The genus *Episthmium* Luehe, 1909, is regarded by Odhner (10) and Fuhrmann (6) as a synonym of the genus *Echinochasmus* Dietz, 1909. In placing our species in the former genus we have merely followed Travassos, (18) who described a closely related parasite of the chicken in Brazil under the name *Episthmium oscari.* If both the Brazilian and Philippine helminths possessed well-developed cephalic collars and spines, they would be generically related to a parasite of the dog in India which Verma (19) described under the name *Episthochasmus caninum. Episthmium gallinum* differs from *E. oscari* only in the very small dimensions of its body, its various organs, and eggs.

Family BRACHYLÆMIDÆ Joyeux and Foley, 1930

Syn.: HARMOSTOMIDÆ Witenberg, 1925

BRACHYLÆMUS MALAYENSIS sp. nov. Plate 2, fig. 2.

Two adult specimens of this trematode were collected from a chicken. The parasite should have been placed in the genus *Harmostomum* Braun, 1899, but, according to Joyeux and Foley, (7) the older generic name *Brachylæmus* Dujardin, 1843, refers to the same group of helminths.

Description.—Body elongated, 2 to 2.2 by 0.45 to 0.5 millimeters. Cuticle armed with minute spines from anterior end to near posterior end of body. Oral sucker subterminal, 0.22 by 0.24 to 0.28 by 0.23 millimeter; acetabulum slightly larger than oral sucker, circular in outline, 0.28 to 0.31 millimeter across, at junction of anterior and middle thirds of body length. Mouth opening slitlike, longitudinal; prepharynx tubular, very short; pharynx globular, 0.13 millimeter across; œsophagus absent; intestinal cæca very irregularly twisted, serpentine, reaching to near posterior end of body.

Testes tandem, near posterior end of body, their margins entire; anterior testis 0.2 to 0.22 by 0.28 to 0.32, posterior testis 0.22 to 0.24 by 0.26 to 0.28 millimeter. Vesicula seminalis long and coiled, immediately in front of first testis. Cirrus sac oval, to one side of median line, 0.15 to 0.19 by 0.07 to 0.08 millimeter. Genital pore median or slightly to one side of median line, immediately in front of first testis.

Ovary transversely oval, intertesticular, to one side of median line, 0.12 to 0.13 by 0.18 to 0.22 millimeter. Transverse vitelline ducts as well as vitelline reservoir and shell gland, both of which are inconspicuous, ventral to ovary. Uterus long, with ascending and descending transverse coils, occupying most of intercæcal space in front of anterior testis but not extending beyond acetabular level. Vitelline follicles lateral and mostly extracæcal, extending from middle level of acetabulum to anterior border of first testis or a little in front of that level. Eggs small, oval, operculated, yellowish to brownish, 21 to 23 by 11 to 13 microns.

Excretory pore posterodorsal.

Host.—*Gallus gallus domesticus.*

Location.—Cloaca.

Locality.—Manila?, Philippines.

Type specimens.—Philippine Bureau of Science parastiological collection No. 609.

The Philippine parasite needs only to be compared with the following trematodes which have been reported from chickens in different parts of the world and with which it is most closely related: *Brachylæmus commutatus* (Diesing, 1858) in southern Europe and northern Africa; *B. gallinus* (Witenberg, 1923) in Russian Turkestan; *B. annamensis* (Railliet, 1924) in French Indo-China; *B. horizawai* (Ozaki, 1925) in Japan; and *B. hawaiiensis* (Guberlet, 1928) in Hawaii. The zoological status of these various trematodes is, however, under question. According to Yamaguti(22) *B. horizawai* is identical with *B. gallinus*, while, according to Sinitsin(14) both *B. gallinus* and *B. hawaiiensis* are synonyms of *B. commutatus*. Dollfus,(5) on the other hand, recognizes only *B. commutatus* as valid and regards all the other forms either as synonyms or as varieties of that species. *Brachylæmus malayensis* differs from these different parasites in the relative sizes of its two suckers, the shape of the oral opening, the anterior extent of the uterine coils, and the small size of the eggs.

Family CYATHOCOTYLIDÆ Poche, 1925

MESOSTEPHANUS FREGATUS sp. nov. Plate 3, fig. 2.

Description.—Body 0.6 to 1.3 millimeters long by 0.35 to 0.6 millimeter in maximum width across ovary; divided into a widened anterior part and a short conical posterior part, 0.06 to 0.11 millimeter long; lateral borders of anterior part rolled ventrally and meeting posteriorly at a distance of 0.25 to 0.35 millimeter from posterior end of body. Cuticle armed with numerous minute spines. Oral sucker 0.034 to 0.053 by 0.037 to 0.06 millimeter; pharynx 0.026 to 0.04 by 0.026 to 0.037 millimeter; œsophagus 0.015 to 0.7 millimeter long; intestinal cæca reaching to level of posterior border of second testis. Acetabulum 0.03 to 0.53 by 0.04 to 0.064 millimeter, at junction of anterior and middle thirds of body length. Adhesive organ oval, 0.15 to 0.16 by 0.11 to 0.13 millimeter, a short distance behind acetabulum, with a longitudinal depression.

Testes almost tandem, subspherical to oval; anterior testis partly dorsal to adhesive organ, smaller than posterior testis, 0.11 to 0.24 by 0.14 to 0.24 millimeter, its anterior border usually notched; posterior testis 0.16 to 0.3 by 0.18 to 0.27 millimeter, its posterior border sometimes presenting a notch. Cirrus sac elongated, to one side of median line, 0.3 to 0.44 by 0.05 to 0.08 millimeter, reaching anteriorly to posterior border of first testis or slightly beyond that level and inclosing coiled seminal vesicle, well-developed pars prostatica, and long cirrus. Genital pore at posterior end of body, directed dorsally and communicating with a small genital sinus.

Ovary small, 0.07 to 0.1 by 0.06 to 0.1 millimeter, to one side of median line opposite cirrus sac, adjacent to posterolateral border of first testis. Vitellaria very well developed, consisting of large roundish or irregularly shaped follicles and forming an almost complete circle around adhesive organ and first testis. Uterus short, containing 1 to 7 eggs; vaginal sphincter moderately developed. Eggs oval, yellowish, operculated, 86 to 98 by 67 to 75 microns.

Host.—*Fregata ariel ariel.*

Location.—Small intestine.

Locality.—Obando, Bulacan Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 547.

The genus *Mesostephanus* Lutz, 1935, comprises the following previously described species: *M. appendiculatus* (Ciurea, 1916), *M. appendiculatoides* (Price, 1934), *M. fajardensis* (Price, 1934), *M. milvi* Yamaguti, 1939, and *M. burmanicus* Chatterji, 1940. Compared with these, *M. fregatus* bears the closest resemblance to *M. appendiculatus* and *M. milvi.* It may be distinguished from *M. appendiculatus* by the more profuse development of its vitellaria, the more anterior position of its acetabulum, and its slenderer cirrus sac; and from *M. milvi* by the smaller size of its cirrus sac and adhesive organ, its relatively longer intestinal cæca, and the presence of a vaginal sphincter.

MESOSTEPHANUS HALIASTURUS sp. nov. Plate 3, fig. 3.

Description.—Body 0.7 to 0.9 millimeter long by 0.3 to 0.4 millimeter in maximum width across ovary; anterior part well expanded, its lateral borders rolled ventrally and meeting posteriorly at a level 0.18 to 0.25 millimeter from posterior end of body; posterior part short, 0.05 to 0.11 millimeter long. Cuticle armed with numerous small spines. Oral sucker subterminal, 0.04 to 0.06 by 0.05 to 0.06 millimeter; acetabulum equatorial, slightly larger than oral sucker, 0.05 to 0.07 millimeter in diameter. Pharynx 0.03 to 0.05 millimeter across; œsophagus 0.04 to 0.08 millimeter long; intestinal cæca extending posteriorly as far as junction of anterior and posterior parts of body. Adhesive organ 0.13 to 0.15 by 0.09 to 0.13 millimeter, with a longitudinal depression.

Testes subglobular to oval, tandem, postequatorial; anterior testis partly dorsal to adhesive organ, 0.08 to 0.11 by 0.09 to 0.12 millimeter; posterior testis 0.08 to 0.11 by 0.10 to 0.13 millimeter. Cirrus sac elongated, to one side of median line, 0.22 to 0.37 by 0.06 to 0.08 millimeter, reaching anteriorly to middle level of first testis or even beyond that level. Genital pore at posterior end of body, directed dorsally and communicating with a shallow genital sinus.

Ovary globular, 0.05 to 0.07 millimeter in diameter, slightly to one side of median line opposite cirrus sac, ventral to first testis. Vitellaria moderately developed, consisting of small elongate follicles and forming a complete ring around adhesive organ. Uterus short, with 1 to 3 eggs; vaginal sphincter well developed. Eggs oval, yellowish, operculated, 83 to 98 by 64 to 83 microns.

Host.—*Haliastur intermedius.*

Location.—Small intestine.

Locality.—Pampanga Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 563.

The above parasite appears to be very closely related to *Mesostephanus appendiculatus* and *M. appendiculatoides.* It may be distinguished from the former, however, by its longer œsophagus and its smaller cirrus sac, adhesive organ and eggs; and from the latter by the more expanded anterior part of its body, the lateral borders of which are rolled ventrally.

LITERATURE CITED

1. BEQUAERT, J. C., and W. J. CLENCH. Philippine Lymnaeidae and Planorbidae. Philip. Journ. Sci. 69 (1939) 7–23.
2. BRAUN, M. Fascioliden der Vögel. Zool. Jahrb. Abt. f. Syst. 16 (1902) 1–162.
3. CHATTERJI, R. C. Helminth parasites of the snakes of Burma, I. Trematoda. Philip. Journ. Sci. 71 (1940) 381–401.
4. CIUREA, J. Prohemistomum appendiculatum, eine neue Holostomiden-Art aus Hunde- und Katzendarm, dessen Infektionsquelle in den Suesswasserfischen zu suchen ist etc. Zeitschr. f. Infektionskrankh. parasit. Krank u. Hyg. d. Haustiere 17 (1916) 309–328.
5. DOLLFUS, R. P. Sur quelques Brachylaemus de la fauna francaise recoltes principalement a Richelieu (Indre-et-Loire). Ann. Parasit. 13 (1935) 52–79.
6. FUHRMANN, O. Trematoda. Kuekenthal's Handbuch der Zoologie 2 (1928) 1–128.
7. JOYEUX, C., and H. FOLEY. Les helminthes de Meriones Shawi Rozet dans le nord de l'Algerie. Bull. Soc. Zool. France 55 (1930) 353–374.
8. JOYEUX, C., J. G. BAER, and J. TIMOM-DAVID. Recherches sur les trematodes du genre Brachylaemus Dujardin (syn. Harmostomum). Bull. Biol. France Belgique 68 (1934) 385–418.
9. MACY, R. W. Studies on the taxonomy, morphology and biology of Prosthogonimus macrorchis Macy, a common oviduct fluke of domestic fowls in North America. Univ. Minnesota Agric. Exper. Sta. Tech. Bull. 98 (1934) 1–71.
10. ODHNER, T. Nordostafrikanische Trematoden, groesstenteils vom Weissen Nile. I. Fascioliden. Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901, under the direction of L. A. Jaegerskioeld, No. 23 A (1910 1–170.
11. PENNER, L. R. Tamerlania melospizae n. sp. (Trematoda. Eucotylidae) with notes on the genus. Journ. Parasit. 25 (1939) 421, 422.
12. PRICE, E. W. New trematode parasites of birds. Smithson. Misc. Coll. 91 (1934) 1–6.
13. SANTOS, V. DOS. Monostomose renal das aves domesticas. Rev. Dep. Nac. Prod. Animal Brasil. 1 (1934) 203–215.
14. SINITSIN, D. Studien ueber die Phylogenie der Trematoden. V. Revision of Harmostominae in the light of new facts from their morphology and life history. Zeitschr. f. Parasitenk. 3 (1931) 786–835.
15. TUBANGUI, M. A. Trematode parasites of Philippine vertebrates. Philip. Journ. Sci. 36 (1928) 351–371.
16. TUBANGUI, M. A. Trematode parasites of Philippine vertebrates. V. Flukes from birds. Philippine Journ. Sci. 47 (1932) 369–404.
17. TUBANGUI, M. A. Observations on the life histories of Euparyphium murinum Tubangui, 1931, and Echinostoma revolutum (Froelich, 1802) (Trematoda). Philip. Journ. Sci. 47 (1932) 497–513.

18. TRAVASSOS, L. Informacoes sobre a fauna helminthologica de Matto Grosso. Folha Med. 3 (1922) 187–190.
19. VERMA, S. C. Studies on the Indian species of the genus Echinochasmus. On an allied new genus Episthochasmus. Proc. Indian Acad. Sci. 1 (1935) 837–856.
20. WITENBERG, G. Versuch einer Monographie der Trematodenunterfamilie Harmostominae Braun. Zool. Jahrb. Abt. f. Syst. 51 (1925) 167–254.
21. WITENBERG, G., and F. ECKMAN. On the classification of the trematode genus Prosthogonimus. Volumen Jubilare pro Professore Sadao Yoshida 2 (1939) 129–143.
22. YAMAGUTI, S. Studies on the helminth fauna of Japan. Pt. 1. Trematodes of birds, reptiles and mammals. Japanese Journ. Zool. 5 (1933) 1–134.
23. YAMAGUTI, S. Studies on the helminth fauna of Japan. Pt. 25. Trematodes of birds. IV. Japanese Journ. Zool. 8 (1939) 129–210.

ILLUSTRATIONS

[Drawings by Baldomero Escuardo.]

PLATE 1

FIG. 1. *Prosthogonimus pseudopellucidus* sp. nov., entire worm, ventral view, with vitellaria reaching posteriorly beyond posterior level of testes.

2. *Prosthogonimus pseudopellucidus* sp. nov.; entire worm, ventral view, with vitellaria extending posteriorly only to anterior level of testes.

3. *Prosthogonimus cuneatus* (Rudolphi, 1809); entire worm, ventral view.

PLATE 2

FIG. 1. *Tamerlania bragai* Dos Santos, 1934; entire worm, ventral view.

2. *Brachylæmus malayensis* sp. nov.; entire worm, ventral view.

PLATE 3

FIG. 1. *Episthmium gallinum* sp. nov.; entire worm, ventral view.

2. *Mesostephanus fregatus* sp. nov.; entire worm, ventral view.

3. *Mesostephanus haliasturus* sp. nov.; entire worm, ventral view.

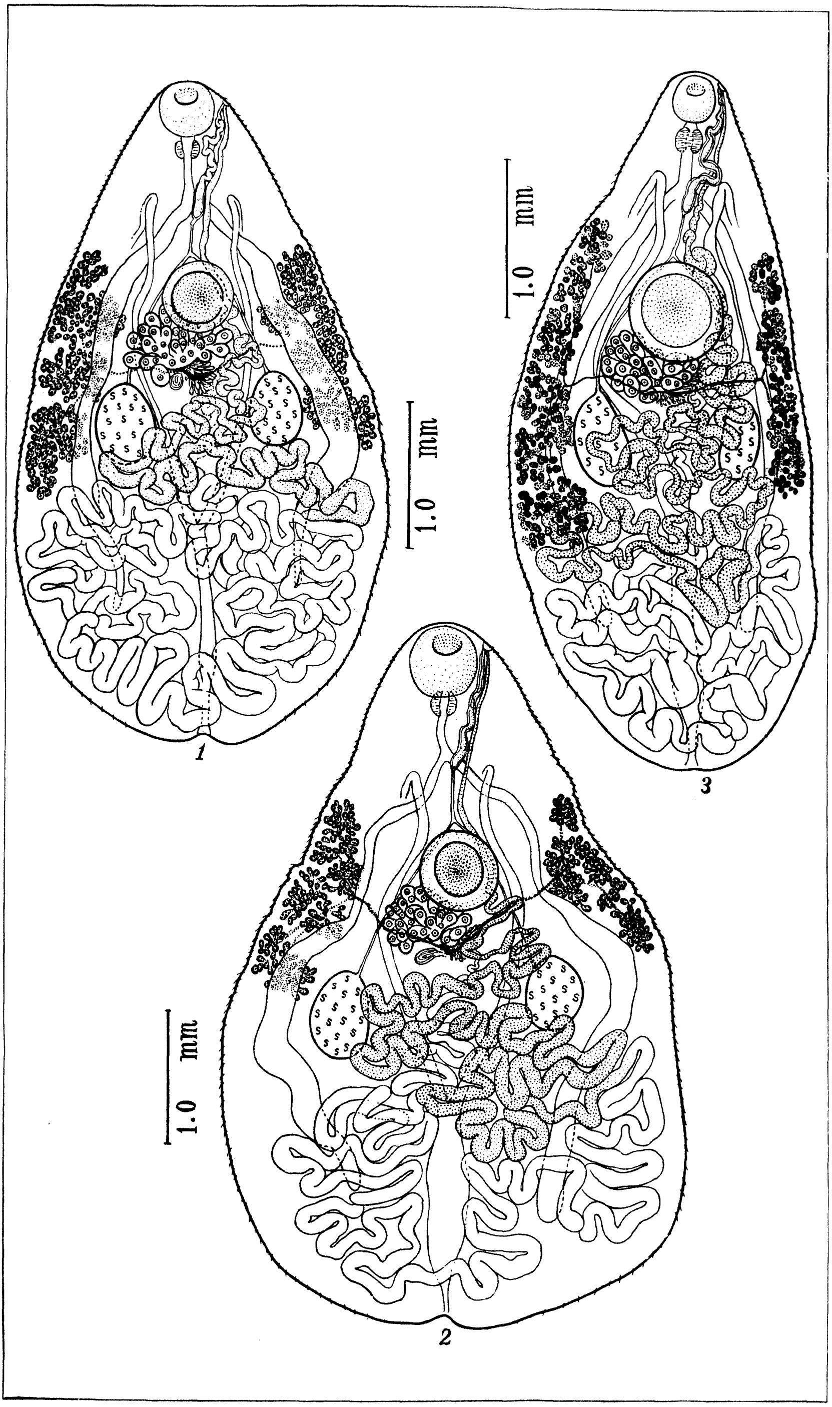
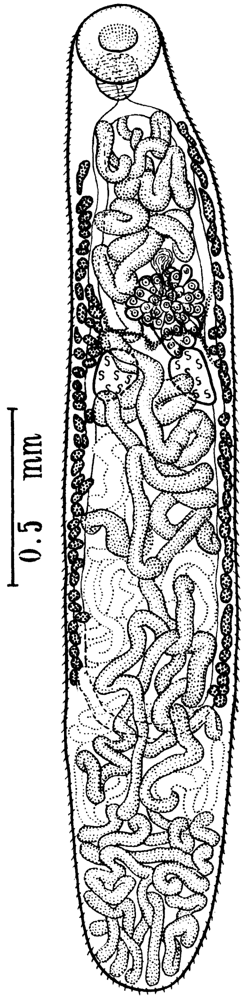


PLATE 1.



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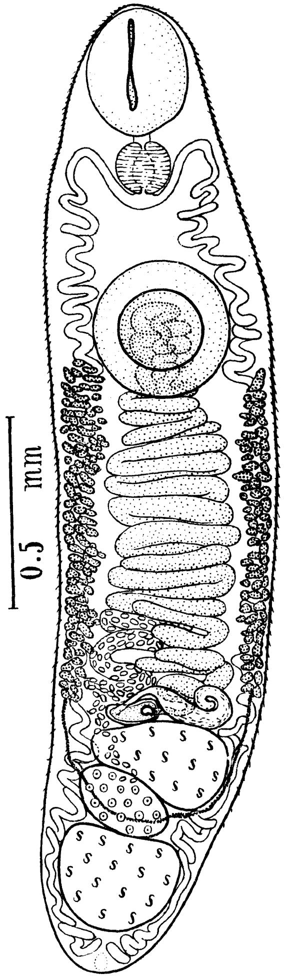

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PLATE 2.

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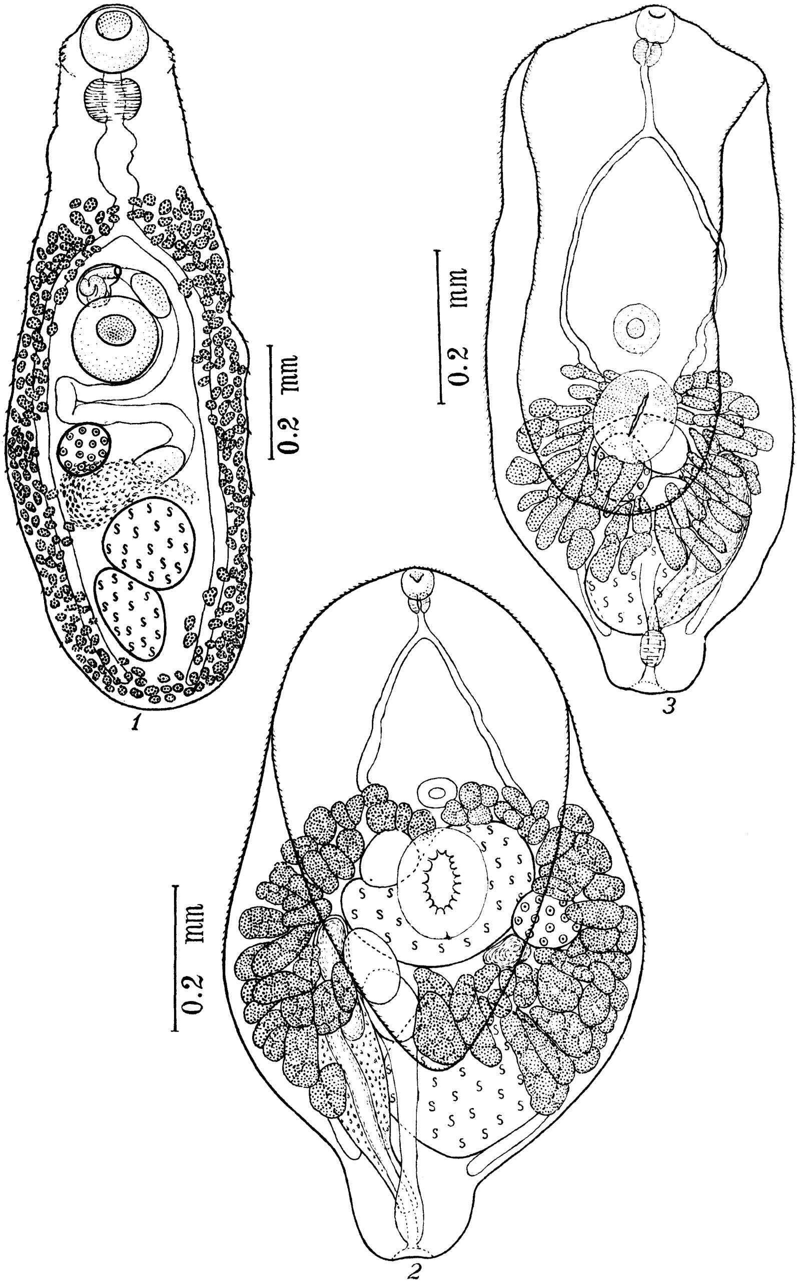

PLATE 3.

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CHEMICAL STUDIES ON COCONUT PRODUCTS, IV

FURTHER DATA ON A NEW PROCESS FOR THE EXTRACTION OF COCONUT OIL

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ONE TEXT FIGURE

In a previous article[1] it has been pointed out that, since the present manufacture of coconut oil involves a stage (the copra stage) in which the moisture content of the dried coconut meat cannot easily be controlled during drying, storage, and transportation, and which therefore is responsible for the development of molds, copra bugs, and other contaminations, and for the consequent deterioration of the quantity and quality of the oil and its byproducts, a more profitable way of utilizing the coconut should start directly with the fresh meat. It has also been shown in the article cited that as between the cage hydraulic press and the roller mill the latter gives better results from the standpoint of efficiency of oil extraction.

The present article gives more detailed data on the extraction of coconut oil emulsion by the roller mill. The experiments on which these data are based were carried out beginning March and ending June, 1940. Various factors were studied; namely, effects of pressure, water dilution, successive order of pressing, and particle size.

The rollers used, made of cast iron, were those described in the article cited above, except that their effective length was decreased from 28 to 24 inches, due to certain improvements made necessary for preventing the flow of the coconut oil emulsion along with the pressed meat. This time, however, the amount of water mixed with the meat was definitely controlled and the meat and water were thoroughly mixed before being placed on the feeder which was actuated by a cam.

Unfortunately these rollers were not equipped with a pressure indicator, and our results cannot therefore be expressed in terms of definite pressures; however, in view of the nature of our data, specially those referring to the oil content of the dried cake, it should not be difficult to duplicate our findings with rollers which are equipped with a pressure gage.[2]

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[1] V. G. Lava, P. E. Torres, and S. Sanvictores, Chemical Studies on coconut products, III. Philip. Journ. Sci. 74 (1941) 247–283.

EXPERIMENTAL DATA

Table 1 shows the effects of pressure and of the amount of water mixed with the comminuted coconut meat on the efficiency of oil extraction and on the time of extraction.

The rollers had a speed of 3.9 R. P. M.; the water used was such as to give a temperature to the mixture of meat and water of around 41 to 46° C.; and the average size of the comminuted particles of coconut meat was 10.4 by 5 by 2.1 mm. The pressures indicated are all empirical. They show distances from a certain fixed stratum to a movable point attached to the upper roller, and thus indicate the distances to which the springs of the rollers have been pressed. For example, the difference between pressure index 79 and pressure index 84 is that for the latter pressure the springs have been further pressed a distance of 5 mm. In all the experiments in Table 1, 50 nuts were used in each batch, although the calculations are for 1,000 nuts.

Due to the comparatively small number of nuts used, and the consequently unreliable determination of actual oil yield, the method used in this work for calculating the efficiency of oil extraction was to weigh the fresh meat and the cakes produced, and to determine the water and oil contents of samples of fresh meat, and of the coconut cakes from the first, second, and third pressings. From these data the amounts of oil and nonoil solids extracted from the fresh meat were calculated, and the efficiency of oil extraction determined.

Table 2 shows the effects of the amount of water mixed with the comminuted meat and of the successive order of pressures used, on the efficiency of oil extraction and on the time of extraction. Here again the rollers had a speed of 3.9 R. P. M. and the average size of the comminuted meat was 10.4 by 5 by 2.1 mm. The temperature of the water used was around 30° C. In all the experiments in Table 2 as well as in Table 4, 100 nuts

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[2] Tests made by the Honolulu Iron Works, Manila, show that the relation between the load and the pressure index may be defined by the linear equation $x = \frac{y-61}{0.0082}$, where x = load in kilograms, and y = pressure index in millimeters.

TABLE 1.—*Effects of pressure and dilution on the efficiency of oil extraction from, and on the time of extraction of, ground coconut meat.*

Speed of rollers, 3.9 R.P.M.
Temperature of mixture of meat with water, 41–46°C.
Average particle size, 10.4 × 5 × 2.1 mm.
The nuts were obtained from Cabubuhayan, Calumpang, Laguna Province.

Experiment.	Weight per 1,000 nuts.	Weight of fresh meat per 1,000 nuts.	Water in fresh meat, wet basis.	Oil in fresh meat, wet basis.	Nonoil solids in fresh meat, wet basis.	Pressure used, empirical.	Water used, based on actual weight.			Weight of cake in different pressings, based on weight of fresh meat.		
							Pressing.					
							1	2	3	1	2	3
	Kg.	*Kg.*	*Per cent.*	*Per cent.*	*Per cent.*	*mm.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3	755	355	52.9	31.3	15.8	79	0	50	50	53	39	36
4	745	335	53.6	30.4	16.0	79	50	50	50	55	42	39
5	745	360	54.3	32.0	13.7	79	100	100	100	56	44	38
6	710	330	51.3	33.3	15.4	81	0	50	50	52	36	32
7	725	330	51.2	33.0	15.8	81	50	50	50	51	41	33
8	750	385	54.9	30.4	14.7	81	100	100	100	49	36	34
9	758	365	51.7	33.2	15.1	83	0	50	50	40	32	29
10	770	370	52.2	31.8	16.0	83	50	50	50	42	35	33
11	774	375	51.8	32.6	15.6	83	100	100	100	41	34	32
12	770	355	51.0	33.5	15.5	84	0	50	50	34	33	31
13	779	365	51.8	32.6	15.6	84	50	50	50	31	29	28
14	775	365	52.6	33.0	14.4	84	100	100	100	32	31	30

TABLE 1.—*Effects of pressure and dilution on the efficiency of oil extraction from, and on the time of extraction of, ground coconut meat*—Continued.

Experiment.	Oil extracted in different pressings.			Nonoil solids extracted in different pressings.			Time of extraction in different pressings, in minutes per 1,000 nuts.			Remarks.
	Pressing.									
	1	2	3	1	2	3	1	2	3	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*min.*	*min.*	*min.*	
3	60	79	85	21	37	45	220	104	104	Good mats of pressed cake.
4	56	69	73	31	46	48	70	80	84	
5	58	67	74	24	35	39	60	68	70	
6	65	79	84	18	39	45	104	72	80	
7	67	73	81	36	38	46	72	80	80	
8	60	75	80	33	40	42	102	108	116	
9	79	93	96	26	27	37	960	300	260	Extraction difficult and messy.
10	71	86	92	30	37	37	140	400	280	Little extract from second and third extractions.
11	71	86	90	34	37	37	200	280	260	
12	82	93	95	27	30	42	800	320	280	Extraction difficult and messy.
13	83	92	96	40	42	46	240	360	260	Very little extract from 2d and 3d extractions.
14	83	92	96	27	28	35	240	360	240	Good mat in first extraction; some feed pressure necessary for second and third extractions.

TABLE 2.—*Effects of dilution and of varying order of successive pressures on the efficiency of oil extraction and on the time of extraction.*

Speed of rollers, 3.9 R.P.M.
Temperature of water used, 30°C.
Average particle size, 10.4 by 5 by 2.1 mm.

Experiment.	Weight of 1,000 nuts.	Weight of fresh meat per 1,000 nuts.	Water in fresh meat, wet basis.	Oil in fresh meat, wet basis.	Nonoil solids in fresh meat, wet basis.	Pressure used, empirical.	Water used, based on actual weight.			Cake in different pressings, based on weight of fresh meat.			Oil extraction in different pressings.			Nonoil solids extraction in different pressings.			Time of extraction in different pressings, minutes per 1,000 nuts.		
							Pressing.														
							1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	Kg.	*Kg.*	*Per cent.*	*Per cent.*	*Per cent.*	*mm.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*min.*	*min.*	*min.*
15	774	335	51.3	33.0	15.7	1-82	75	-----	-----	49	-----	-----	66	-----	-----	30	-----	-----	100	-----	-----
						2-82	50	100	-----	49	37	-----	65	81	-----	25	30	-----	110	108	-----
						3-82	25	-----	100	50	-----	33	64	-----	85	23	-----	35	112	-----	125
							0	-----	-----	48	-----	-----	70	-----	-----	35	-----	-----	160	-----	-----
16	796	385	51.5	34.0	14.5	1-82	75	-----	-----	48	-----	-----	65	-----	-----	28	-----	-----	100	-----	-----
						2-81	50	100	-----	50	37	-----	-----	79	-----	-----	36	-----	104	90	-----
						3-80	25	-----	100	50	-----	35	64	-----	80	21	-----	45	130	-----	85
							0	-----	-----	45	-----	-----	71	-----	-----	20	-----	-----	180	-----	-----
17	783	377	52.0	32.1	15.9	1-80	50	-----	-----	55	-----	-----	59	-----	-----	23	-----	-----	91	-----	-----
						2-81	-----	100	-----	-----	43	-----	-----	70	-----	-----	30	-----	-----	96	-----
						3-82	-----	-----	100	-----	-----	37	-----	-----	79	-----	-----	38	-----	-----	122
[a] 18	788	366	50.3	35.0	14.7	1-83	50	-----	-----	44	-----	-----	72	-----	-----	31	-----	-----	260	-----	-----
						2-83	-----	100	-----	-----	34	-----	-----	84	-----	-----	45	-----	-----	180	-----
						3-83	-----	-----	100	-----	-----	31	-----	-----	91	-----	-----	51	-----	-----	160
20	788	353	51.9	32.2	15.9	1-84	50	-----	-----	34	-----	-----	77	-----	-----	30	-----	-----	260	-----	-----
						2-84	-----	100	-----	-----	32	-----	-----	91	-----	-----	43	-----	-----	290	-----
						3-84	-----	-----	100	-----	-----	32	-----	-----	96	-----	-----	48	-----	-----	220
21	779	363	50.1	33.0	16.9	1-82	50	-----	-----	48	-----	-----	63	-----	-----	36	-----	-----	150	-----	-----
						2-83	-----	100	-----	-----	32	-----	-----	83	-----	-----	46	-----	-----	150	-----
						2-84	-----	-----	100	-----	-----	25	-----	-----	90	-----	-----	47	-----	-----	175

[a] Beginning with this experiment, the feeder actuated by the cam was taken away, and feeding was done by hand alone.

were used in each batch, although the calculations are for 1,000 nuts. From Experiment 18 of Table 2 to the end of the experiments in Table 4, feeding by hand alone was substituted for feeding with the help of a cam.

Table 3 not only gives a resumé of Tables 1 and 2 but also shows the effects of pressure and of the amount of water mixed with the comminuted meat, on the oil content of the dried pressed coconut meat (after the third pressing).

Table 4 shows the effects of the speed of the rollers, of the average size of the particles of comminuted meat, and of pressure, on the efficiency of oil extraction, on the oil content of the dried pressed coconut meat, on the time of extraction, and on the amount of tailings produced.

In Tables 1, 2, and 4 the weights of 1,000 husked nuts and fresh meat, and the percentages of water, total obtainable oil, and nonoil solids are given.

The possible errors in measurements of weight of fresh meat throughout the above experiments may be considered not more than 2 in 39 or around 5 per cent.

DISCUSSION OF RESULTS

In Table 1, for the same pressure, different amounts of water were used. In one case no water at all was used. In the first pressing, and 50 per cent water, based on the weights of the pressed meat, in the second and third pressings; in another case 50 per cent water was used in the first pressing, based on the weight of the fresh meat, and 50 per cent water, based on the weights of the pressed meat, in the second and third pressings; in the third case 100 per cent water was used in the first pressing, based on the weight of the fresh meat, and 100 per cent water, based on the weights of the pressed meat, in the second and third pressings.

Table 1 shows that while the less the amount of water used for mixing with the meat the greater is the degree of extraction of oil, especially for the lower pressures, at the same time the period of extraction becomes longer when less water is used. In general, when 50 per cent water is used in the first pressing, based on the weight of the fresh meat, the period of extraction is least; and for the second and third extractions, 100 per cent water, based on the weight of the pressed coconut meat, seems to be necessary for reducing the period of extraction to the minimum.

TABLE 3.—*Effects of pressure and dilution on the oil content of the sapal.*

Speed of rollers, 3.9 R.P.M.
Temperature of water 30–46°C.
Average particle size, 10.4 by 5.0 by 2.1 mm.

Experiment.	Pressure, empirical.	Water used, based on weight of fresh meat.			Cake after pressing, based on fresh meat.			Oil in cake from different pressings, dry basis.			Efficiency of oil extraction in different pressings.		
		Pressing.											
		1	2	3	1	2	3	1	2	3	1	2	3
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3	79	0	50	50	53	39	36	49.9	38.9	33.5	60	79	85
4	79	50	50	50	55	42	39	54.7	52.6	49.8	56	69	73
5	79	100	100	100	56	44	38	56.9	54.0	49.2	58	67	74
6	81	0	50	50	52	36	32	48.1	43.1	38.8	65	79	84
7	81	50	50	50	51	41	33	52.0	48.6	42.9	67	73	81
8	81	100	100	100	49	36	34	55.4	47.1	40.6	60	75	80
9	83	0	50	50	40	32	29	35.6	17.0	11.2	79	93	96
10	83	50	50	50	42	35	33	47.8	28.7	18.5	71	86	92
11	83	100	100	100	41	34	32	49.0	33.9	24.0	71	86	90
12	84	0	50	50	34	33	31	34.8	16.8	15.7	82	93	95
13	84	50	50	50	31	29	28	36.0	19.2	14.0	83	92	96
14	84	100	100	100	32	31	30	38.0	21.7	12.8	83	92	96
15	82	[a] 38	100	100	49	37	33	48.8	37.0	34.2	[a] 66	81	85
16	82, 81, 80	[a] 38	100	100	48	37	35	50.1	44.0	37.8	[a] 67	79	80
17	80, 81, 82	50	100	100	55	43	37	52.0	48.2	41.9	59	70	79
18	83	50	100	100	44	34	31	48.0	40.5	29.8	72	84	91
20	84	50	100	100	34	32	32	39.5	24.5	15.6	77	91	96
21	82, 83, 84	50	100	100	48	32	25	52.6	39.6	27.6	63	83	90

[a] Average value.

TABLE 4.—*Effects of speed of rollers, of particle size, and of pressure on the efficiency of oil extraction, time of extraction, and on the amount of tailings produced.*

Water used in first pressing, 50 per cent of fresh meat.
Water used in second pressing, 100 per cent of 1st pressed meat.
Water used in third pressing, 100 per cent of 2d pressed meat.
Temperature of water used, 30°C.

Experiment.	Source of nuts.	Weight per 1,000 nuts.	Weight of fresh meat per 1,000 nuts.	Water in fresh meat, wet basis.	Oil in fresh meat, wet basis.	Nonoil solids in fresh meat, wet basis.	Speed of rollers.	Pressure used, empirical.	Average size of particles.	Cake in different pressings, based on fresh meat.			Tailings in different pressings.		
										Pressing.					
										1	2	3	1	2	3
		Kg.	*Kg.*	*Per cent.*	*Per cent.*	*Per cent.*	*r. p. m.*	*mm.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18	Cabubuhayan, Calumpang.	788	366	50.3	35.0	14.7	3.9	83	10.4×5.0×2.1	44	34	31	3	8	10
20	do	788	353	51.9	32.2	15.9	3.9	84	10.4×5.0×2.1	34	32	32	(?)	10	25
21	do	779	363	50.1	33.0	16.9	3.9	82,83,84	10.4×5.0×2.1	48	32	25	2	7	16
22	do	774	354	50.3	33.9	15.8	5.4	83	10.4×5.0×2.1	39	30	30	11	25	34
23	do	782	355	51.5	32.9	15.6	5.4	82,83,84	10.4×5.0×2.1	45	29	27	2	12	22
24	do	780	348	53.0	31.1	15.9	3.6	83	10.4×5.0×2.1	45	32	28	3	7	12
25	Nagcarlang	800	400	52.4	31.7	15.9	3.6	83,83,84	10.4×5.0×2.1	40	28	26	5	11	20
26	do	811	440	50.5	33.6	15.9	3.6	83,84,84	10.4×5.0×2.1	45	28	25	4	11	12
27	do	806	434	51.6	32.3	16.1	3.6	83,84,84	6.2×2.2×1.0	35	25	25	5	11	14
28	do	819	461	52.3	31.8	15.9	3.6	83,84,84	11.0×7.2×3.3	47	29	26	3	8	11
29	Riverside, Calumpang.	805	422	49.7	34.4	15.9	3.6	84	7.1×2.5×1.2	33	26	25	4	8	11
30	do	803	431	49.7	34.3	16.0	3.6	84	5.9×1.8×0.9	28	24	25	13	13	17
[a] 31	do	801	419	50.6	33.4	16.0	3.6	84	5.9×1.8×0.9	32	27	23	6	10	14
[b] 32	Nagcarlang	818	416	50.6	33.4	16.0	3.6	84	5.9×1.8×0.9	28	25	24	12	18	20

Experiment.	Time of extraction in different pressings, minutes per 1,000 nuts.			Efficiency of oil extraction.			Efficiency of extraction of nonoil solids.			Oil in different pressings, dry basis.			Remarks.
	Pressing.												
	1	2	3	1	2	3	1	2	3	1	2	3	
	min.	*min.*	*min.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
18	260	180	160	72	84	91	31	45	51	48.0	40.5	29.8	
20	260	290	220	77	91	96	30	43	48	39.5	24.5	15.6	
21	150	150	175	63	83	90	36	46	47	52.6	39.6	27.6	
22	210	240	170	77	91	95	33	46	46	42.1	25.3	13.8	
23	150	160	205	68	87	93	35	45	45	50.1	32.7	20.3	Very little extract in third extraction.
24	185	180	157	67	82	88	34	45	45	48.9	38.0	29.3	
25	270	200	190	73	87	91	39	44	44	46.6	33.9	24.8	
26	215	240	180	68	87	92	33	44	44	50.5	33.5	23.3	
27	235	210	150	79	89	92	43	48	48	43.0	29.1	21.1	Fresh meat ground twice before extraction.
28	240	230	200	57	84	91	42	45	45	59.7	36.8	25.4	Very good continuous mat even in third extraction.
29	225	160	125	81	90	93	40	46	46	41.7	28.8	20.9	Very good paperlike mat in 3d extraction.
30	280	180	160	88	94	96	41	41	41	31.6	17.0	12.2	Do.
[a] 31	230	240	120	85	91	94	45	45	48	37.1	23.4	20.4	Do.
[b] 32	260	180	155	86	93	95	46	46	48	34.5	21.7	16.0	Do.

[a] Water used in 1st extraction, 75 per cent.
Water used in 2d extraction, 50 per cent.
Water used in 3d extraction, 0 per cent.

[b] Water used in 1st extraction, 50 per cent.
Water used in 2d extraction, 100 per cent.
Water used in 3d extraction, 50 per cent.

Table 1 also shows that while a pressure equivalent to our empirical pressure index 79 will give an oil extraction of 73 to 85 per cent, at pressure index 84 we can get an oil extraction as high as 96 per cent. The difference in the use of these two pressures, from the standpoint of period of extraction, is that while with the lower pressure around 20,000 nuts per day of 24 hours can be pressed by the rollers used, with the higher pressure only around 6,000 nuts can be pressed per day.

Table 2 confirms the above conclusions. In Experiments 15 and 16, in the first pressing, when no water is mixed with the comminuted meat, although the degree of oil extraction is comparatively higher, the period of extraction is much longer than when water is used. Again these two experiments indicate that 50 per cent water mixed with the meat before pressing gives good results. The use of 75 per cent water, while giving a slightly shorter period of extraction, has also the effect of diluting the skimmed coconut milk obtained after centrifuging the coconut oil emulsion, which is not advisable, especially if this skimmed coconut milk byproduct may have to be evaporated later.

Experiments 15, 16, and 17 show clearly that a high pressure used throughout the three extractions (82) gives a higher efficiency of extraction than when it is used as a maximum pressure only, either at the beginning (82, 81, 80) or at the end (80, 81, 82). This result is also verified by Experiments 20 and 21.

Under the conditions of the experiment a 96 per cent oil extraction can be obtained with a pressure index of 84 throughout the three pressings (Experiment 20), at a rate of pressing of around 5,500 nuts per day.

From Experiment 18, in Table 2, up to the end of the experiments in Table 4, the feeder actuated by a cam was taken away, and feeding was done by hand alone; this change was found necessary with the use of high pressures, since the consistency of the meat-water mixture apparently prevented a constant and continuous feed into the rollers unless the mixture was moved back and forth along the length of the roller.

In the case of the extraction of nonoil solids, Table 2 shows that while with pressure index 82 (Experiment 15) around 35 per cent of the total nonoil solids is extracted, with pressure index 83 (Experiment 18) the degree of extraction is around 51 per cent, and with pressure index 84 (Experiment 20) the degree of extraction is around 48 per cent. The increase in the extraction of nonoil solids, when the pressure is not continuously at its highest (Experiments 16 and 17 as compared with Experiment 15) requires further elucidation, especially in view of the fact that in Table 1 fairly great variations were found in the degree of extraction of these nonoil solids with changes in the amount of water used for mixing and sometimes even with no changes at all in the amount of water.

The relation between the efficiency of oil extraction and pressure, from Experiments 20, 18, 15, 7, and 4 (Table 3), is plotted as shown in text fig. 1.

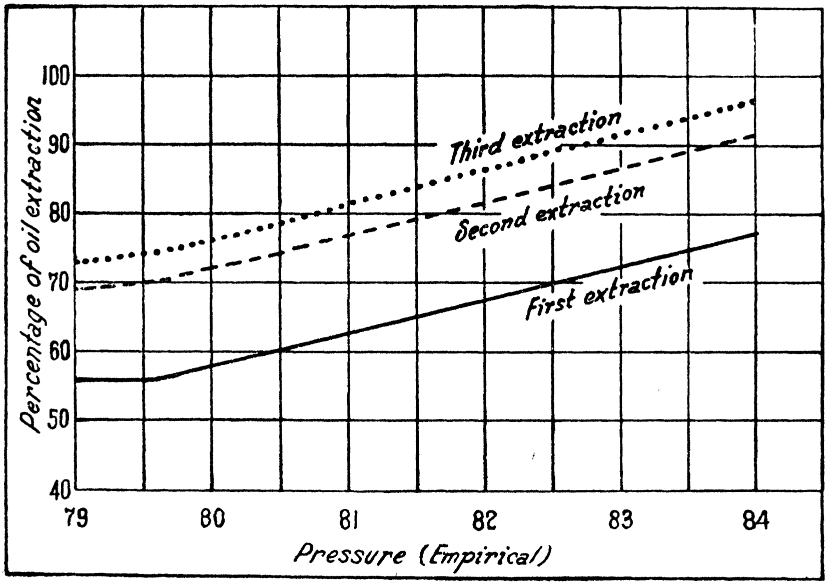

FIG. 1. Percentage of coconut oil extraction at various pressures.

The average percentage of water mixed with the fresh meat for the first pressing in Experiment 15 is 38 per cent instead of 50 per cent, and the percentage of water mixed with the pressed cake in the second and third extractions in Experiments 7 and 4 is 50 per cent instead of 100 per cent, but analysis of Table 3 shows that for approximate purposes this variation in the water of dilution can be allowed. The curves in text fig. 1 show that the relation between pressure and efficiency of oil extraction is linear, as shown definitely by the curve for the third extraction of oil, although this relation is not well defined in the first and second extractions. Text fig. 1 shows that with a pressure index of 84.5 it is possible to raise the efficiency of oil extraction after three pressings to 98 per cent.

Table 3 also shows that in order to get a coconut cake containing 16 per cent oil (dry basis) or less, a pressure index of at least 83 should be used together with little or no water of dilution in the first pressing (Experiment 9). A pressure index of 84 under various conditions of water dilution invariably gives an oil content of less than 16 per cent in the coconut cake after the third pressing (Experiments 12, 13, 14, and 20). Since the oil content of pressed coconut meat plays an important rôle in the salability of the cake, especially if it is to be used as human food and is to be stored for long periods of time, the use of the proper pressure for obtaining a cake of the allowable minimum oil content is important. On the other hand, if it should become commercially more practical to merely get as much oil from the fresh meat as possible, leaving a pressed coconut meat comparable to copra or desiccated coconut in oil content, it may be necessary merely to press the fresh meat once at pressure index 79 to 81; by this method the coconut cake will have an oil content of 48 to 57 per cent, and the percentage of oil extracted will be 56 to 67 per cent (Experiments 3 to 8).

Table 4 shows the effects of the other factors, such as speed of rollers and size of particles of the comminuted meat. With hand feeding, in which the meat is moved back and forth along the rollers, and in which no extra pressure on the feed is exerted, the speed of the rollers within the range employed has no appreciable effect on the time of extraction. However, a higher speed apparently increases the efficiency of oil extraction and decreases the oil content of the coconut cake (Experiments 18, 21, 22, and 23). This observation is subject to verification in later experiments, when the feed is mechanized.

Furthermore, a decrease in the size of the comminuted meat has clearly the effect of increasing the efficiency of oil extraction and of decreasing the oil content of the pressed coconut meat (Experiments 26 to 30). In fact, with a pressure index of 84, and with a roller speed of 3.6 R. P. M., decreasing the size of the particles to 5.9 by 1.8 by 0.9 mm not only gives an oil extraction efficiency of 96 per cent after three pressings, but also raises the efficiency of oil extraction even in the first pressing to 88 per cent. Again, however, the time of extraction does not seem to be appreciably altered by a change in particle size under the conditions of the experiment. The only drawback to a decrease in the size of particles of the comminuted meat seems to be that the tailings which pass through the roller screen but not through the rollers are slightly greater in quantity (Experiments 29 and 30); but this problem of reducing the tailings to a minimum may be solved mechanically.

Tables 1, 2, and 4 show the quality of the nuts, as described by the season during which they are picked or used, by their source, by their weight, by the weights of their meat and of their shells, and by the water content, oil content, and nonoil-solids content of the fresh meat. These characteristics will be discussed more fully in a later paper, but are given in this article in order to permit the making of calculations based on dried copra.

SUMMARY

1. Mixing water with coconut meat in the ratio by weight of 1 part of water to 2 parts of the fresh comminuted meat, or in the ratio of 1 part of water to 1 part of the pressed coconut meat gives mixtures with fluidities that seem to be best adapted for feeding in a roller press.

2. The size of the particles of comminuted meat affects the degree of oil extraction; the greater the size the less the efficiency of extraction, for a given set of rollers. As high as 88 per cent oil extraction can be obtained with the rollers used in one pressing if the meat is comminuted to an average size of 5.9 by 1.8 by 0.9 mm.

3. Under conditions of more or less continuous hand feeding a pressure that after three pressings produces a pressed coconut meat of around 50 per cent oil content (dry basis) will give an oil extraction efficiency of about 73 per cent. If this pressure is used only for one pressing, the oil content of the pressed meat obtained is about 55 per cent, corresponding to an oil extraction efficiency of around 56 per cent. On the other hand, a pressure that after three pressings produces a pressed coconut meat of around 16 per cent oil, will give an oil extraction efficiency of

around 96 per cent. If this latter pressure is used only for one pressing, the oil content of the pressed meat obtained is about 32 to 42 per cent, corresponding to an oil extraction efficiency of about 81 to 88 per cent. Within the range of pressures used the efficiency of oil extraction increases directly with pressure. The selection of the proper pressure to adopt will depend upon the use for which the pressed coconut meat is intended.

4. Without using a mechanical feeder in conjunction with the rollers (diameter, 10 inches; effective length, 24 inches), the capacity of these rollers can be made to vary from 5,500 to 20,000 nuts per day, depending upon whether a high or low oil content in the pressed meat is desired.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Percentage of coconut oil extraction at various pressures.

CLAY-ASBESTOS SHINGLES

By GIL O. OPIANA
Of the Bureau of Science, Manila

TWO PLATES

This report contains an account of hand-made shingles from Philippine clay and asbestos. Manufacture of these shingles has been in progress at the Bureau of Science in recent years. These shingles are fireproof and make a handsome roof that renders the house cool and healthful.[1]

ANALYSIS OF RAW MATERIALS

The clay used in making these shingles was obtained from Molino, Cavite Province. Analysis of this clay is given in Table 1, and physical tests in Table 2. The usual standard chemical and physical methods were employed to obtain these data.

TABLE 1.—*Analysis of Molino clay.*

Constituent.	Per cent.
Silica (SiO_2)	51.00
Alumina (Al_2O_3)	17.05
Iron oxide (Fe_2O_3)	10.53
Lime (CaO)	1.40
Magnesia (MgO)	1.10
Alkalies (K_2O and Na_2O)	1.79
Loss on ignition	15.45

NOTE.—Analysis made by Mr. R. Oliver of the Bureau of Science.

TABLE 2.—*Physical tests of Molino clay.*

Moisture, per cent[a]	7.94
Water of plasticity, per cent	37.48
Slaking time, minutes	10
Volume shrinkage, per cent	39.03
Linear shrinkage	15.20
Tensile strength, pounds per square inch	8.50
Cross breaking	1.62
Drying qualities	Good
Absorption at 900° C.	17.35
Fusing point, °C.[b]	1,180

[a] The material was sieved through a 20-mesh sieve.
[b] Approximate.

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[1] Agricultural and Industrial Monthly (March, 1937) 12.

The asbestos used in this study was supplied by Mr. Baretto of Zambales Province. The chemical analysis of a representative sample is given in Table 3.

TABLE 3.—*Analysis of Philippine asbestos.*

Constituent.	Per cent.
Silica (SiO_2)	52.00
Alumina (Al_2O_3)	3.66
Iron oxide (Fe_2O_3)	3.84
Lime (CaO)	11.40
Magnesia (MgO)	23.61
Alkalies (K_2O and Na_2O)	0.52
Loss on ignition	4.10

NOTES.—The sample was obtained from Zambales Province. The analysis was made by Mr. Oliver of the Bureau of Science.

MIXTURE OF CLAY AND ASBESTOS

After a series of trial mixtures, the mixture adopted, which gave the least warping and cracking on drying and firing, consisted of 6 parts by oven-dry weight of asbestos and 4 parts by oven-dry weight of clay. The asbestos was first crushed in a wet pan [2] to a fine powder. After removal, a known weight of clay, usually 12 kilograms, freed from plant roots, pebbles, and other foreign material, was ground in the same way.

The asbestos was added little by little with continuous mixing. Water was then added in small portions until the right plasticity of the mixture was reached. The well-mixed mass was placed on a galvanized sheet in the drying shed covered with wet sacks and allowed to stand for at least 2 or 3 days to age.[3]

MOLDING, DRYING, AND FIRING

The tile was molded by hand. The mold, which was made of hardwood, was covered with a wet thick cloth (*maong*). Small pieces of the plastic mass were thrown to the two ends and crevice for the anchor. A slice larger than the mold was again thrown into the mold, covered with another piece of dry, thick cloth, and pounded with a wooden pestle all around to fill the mold completely. With a well-stretched galvanized wire tied to the two ends of a semicircular piece of bejuco (rattan) the excess was scraped off. To smooth the surface, a wet iron pallet was passed back and forth. The tile was placed upside down on dry boards with holes $\frac{7}{16}$ inch in diameter, at intervals of $2\frac{1}{2}$ inches, and smeared with powdered grog[4] to prevent the tiles from sticking and to reduce friction.[5] With a pointed $\frac{1}{16}$-inch copper wire a hole was bored through the middle for tying. Three tiles could be put on each board. The loaded boards were placed on racks inside the drying shed. Usually 6 to 7 days were required for slow drying of the tiles.

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[2] The Manufacture of Roofing Tiles. Bull. 11, 4th Series Geol. Survey of Ohio (1910) 230.

[3] A. B. Searle. A Rudimentary Treatise on the Manufacture of Bricks and Tiles. The Technical Press Ltd. 14th ed. (1936) 178.

To further dry the tiles, they were placed side by side in a perpendicular position on another wooden rack in the drying shed for a week or more. These air-dried tiles were fired in a down-draft horizontal kiln[6] with a capacity of 1,200 to 1,300 tiles to cone 08 (940° C).

The steps followed in firing were: smoking, decomposition, soaking, and cooling.[7] Dried pieces of bacauan were used as fuel and a kiln efficiency ranging from 95 per cent to 98 per cent was obtained.

TESTS

A comparison of the products obtained in this study and similar products made locally is given in Table 4.

TABLE 4.—*Moisture absorption of clay-asbestos shingles.*

Shingles.	Per cent.
Bureau of Science, hand-made	25.7–30.5
Torres High School, hand-made	26.7–30.8
Muntinlupa, hand-made	25.5–28.7
Ceramic Industries of the Philippines, machine-made	8.6–14.2

Table 4 shows the results obtained in absorption carried out in accordance with the methods of The American Society of Testing Materials.

The hand-made shingles have about the same percentages of water absorption, while the machine-made shingles have a very much lower percentage of absorption than the hand-made shingles. This marked difference is due to the high temperature of firing employed in the manufacture of machine-made shingles.

Table 5 shows the results obtained for modulus of rupture on a 7-inch span. The tests were made in the Division of Tests and Standards.

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[4] Powdered bagasse ash was used.

[5] H. Wilson, Ceramics-Clay Technology. McGraw Hill Co. 1st ed. (1927) 130.

[6] E. Bourry. Treatise on Ceramic Industries. Scott, Greenwood & Co. (1901) 356.

[7] A. B. Searle. The Chemistry and Physics of Clays and other Ceramic Materials. Ernest Benn Ltd. (1924) 544.

TABLE 5.—*Modulus of rupture of clay-asbestos shingles.*

Shingles.	Pounds.
Bureau of Science, hand-made	125–185
Torres High School, hand-made	150–195
Muntinlupa, hand-made	125–175
Ceramic Industries of the Philippines, machine-made	115–190

Table 5 shows that there is no relation between percentage of absorption and modulus of rupture of shingles. The lowest figure obtained in the hand-made shingles was higher by 10 pounds than that of the machine-made shingles. The highest figure for hand-made shingles was 195 pounds, and for the machine-made shingles, 190 pounds.

SUMMARY

The method of making asbestos shingles is given. Manufacture of asbestos shingles by hand involves the use of simple equipment, so that it has possibilities as a home industry, especially in regions where raw materials and fuel are available.

Very little technique is required in the molding of tiles. An ordinary individual after a day or two of practice can do the work satisfactorily. In the Bureau of Science ordinary laborers molded the tiles, in Muntinlupa, prisoners, and in Torres High School, pupils.

There is no relation between percentage of absorption and modulus of rupture in shingles.

The percentage of absorption of hand-made shingles is about twice that of machine-made shingles.

The modulus of rupture for both machine-made and hand-made shingles is about the same.

ACKNOWLEDGMENT

To Doctor del Mundo of Ceramic Industries of the Philippines and Doctor Manlapas of the Bureau of Prisons, obligations are acknowledged for the generous supply of asbestos shingles used in this study.

ILLUSTRATIONS

PLATE 1

FIG. 1. Molding shingles by hand.
2. Drying shelves.

PLATE 2

FIG. 1. Clay Asbestos shingles.
2. House roofed with shingles.

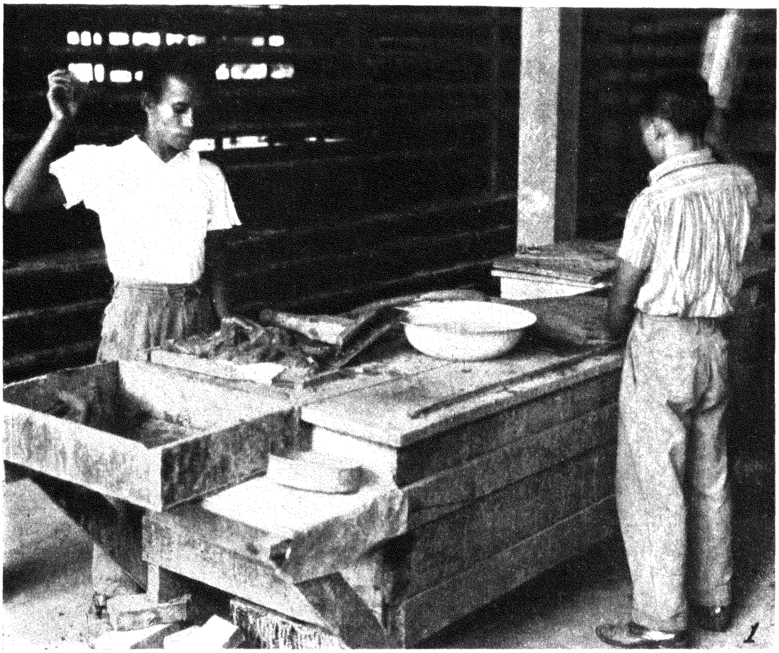

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PLATE 1.

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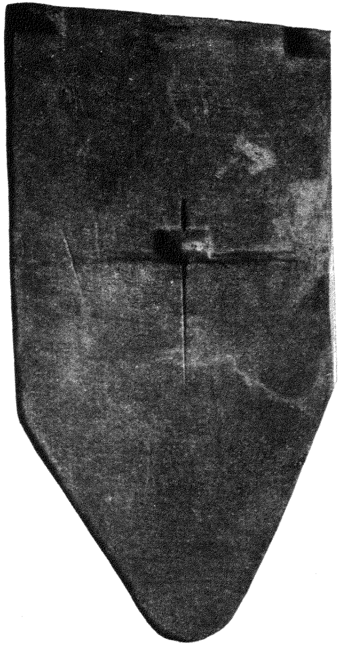

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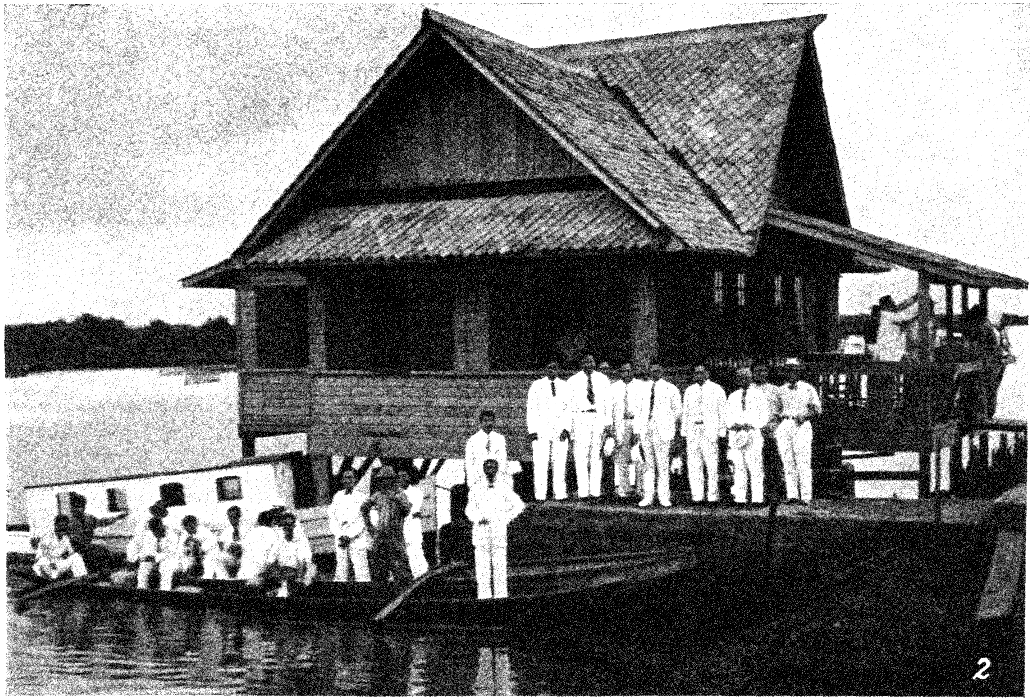

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PLATE 2.

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NEW OR NOTEWORTHY PHILIPPINE FUNGI, III

By JOSÉ M. MENDOZA and SIMEONA LEUS-PALO

Of the Natural History Museum Division, Department of Agriculture and Commerce, Manila

NINE TEXT FIGURES

The last paper under this title was published in 1932.[1] In the present contribution 10 species of the genus *Cercospora* are described as new. Twenty species previously described from extra-Philippine material are for the first time reported from the Archipelago, 10 of these being of the genus *Cercospora,* the rest of the family Agaricaceæ. All the type species and other specimens have been deposited in the Philippine National Herbarium of the Natural History Museum, Manila.

SCOLECOSPORÆ

Genus CERCOSPORA Fressenius

CERCOSPORA ATHYRII Mendoza sp. nov. Text fig. 1.

Maculis amphigenis, plus minusve indefinite sed pluscule similaris, irregulariter, 1 ad 8 mm in diametro, saepe depressis ad maturescens. Conidiophoris abundantis, e basi stromatica. rumpens per aperti, obscuris olivaceis vel griseolis, tandem pallidis vel hyalinis ad apicem, unicus vel multi-septatis, denticulatis circa apice, 33 ad 104 μ × 3.6 ad 4.8 μ. Conidiis abundantis, maxime angustis, obsclavatis, acicularis vel falcatis, multi-septatis, 24 ad 90 μ × 3 ad 5 μ.

Spots amphigenous, more or less indefinite but more inclined to be irregularly circular, 1 to 8 mm in diameter, oftentimes sunken at maturity. Conidiophores abundant, stromatic at base, rupturing from stomata, dark olive to grayish, becoming pale to hyaline toward apex, 1- to many-septate, denticulate near the end, 33 to 104 μ long, 3.6 to 4.8 μ broad. Conidia abundant, very narrow, obclavate, needle-shaped to scythe-shaped or curved, many-septate, 24 to 90 μ long, 3 to 5 μ broad.

LUZON, Manila, *Bur. Sci. 55483 Mendoza* (type in Philip. Nat. Herb.), on leaves of *Athyrium esculentum* Copel.

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[1] Mendoza, J. M., New or noteworthy Philippine Fungi. II. Philip. Journ. Sci. **49** (1932) 185–196.

There is a close resemblance between this fungus and *C. beticola* Sacc. The conidiophores of both species are reticulate, having bent knees and scars on the upper portion or near the apex. They are stromatic at the base. The conidiophores of *C. athyrii,* however, are much longer; moreover, the spores of this fungus are vacuoled and granular, while those of *C. beticola* are hyaline and simple.

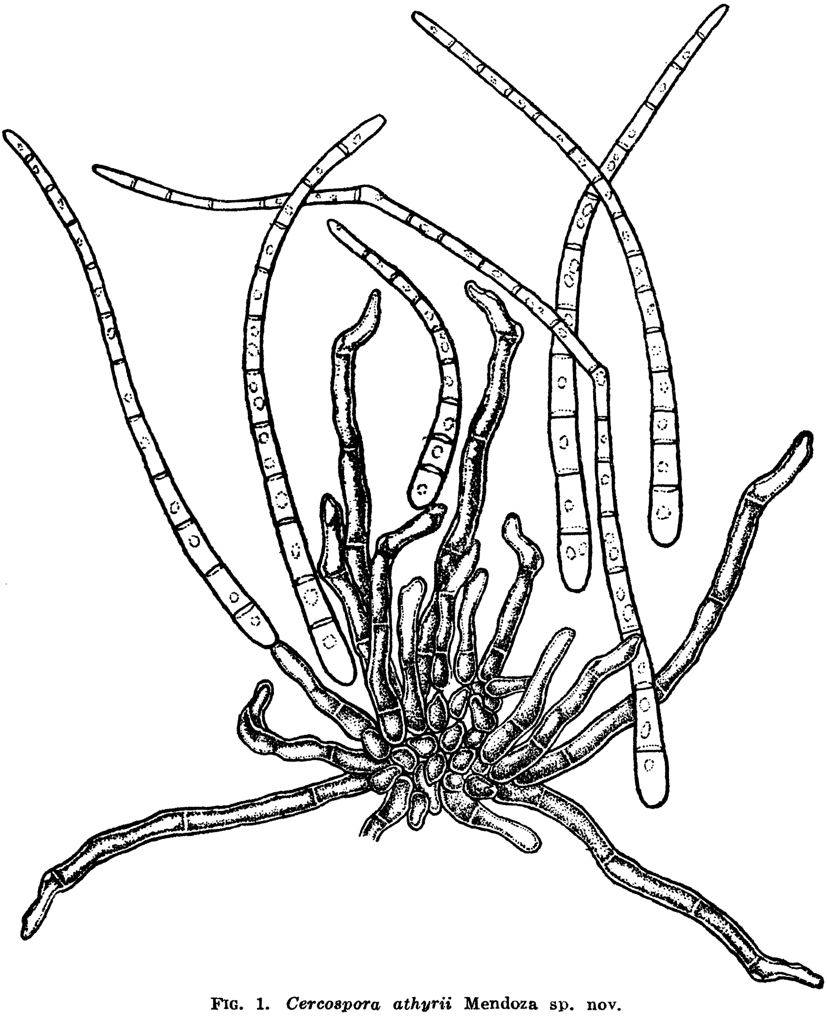

FIG. 1. *Cercospora athyrii* Mendoza sp. nov.

CERCOSPORA BALSAMINAE Mendoza sp. nov. Text fig. 2.

Maculis amphigenis irregulariter rotundatis vel indefinitis formis, disseminatis, saepe confluentis, depressis, zona fusca cir-

cumdatis aetatis, pallidis brunneis in centrum, obscuris brunneis centrifugalis, 1 ad 8 mm in diametro, cum maxime area quam alicui confluentis, saepe totus centrum maculis disrumpens reliqui perforati. Conidiophoris confluentis, pallidis olivaceis griseis, tandem pallidis vel casi hyalinis, longis distans-septatis, subdenticulatis ad vel circa nodus, 60 ad 140 μ × 4 ad 5 μ.

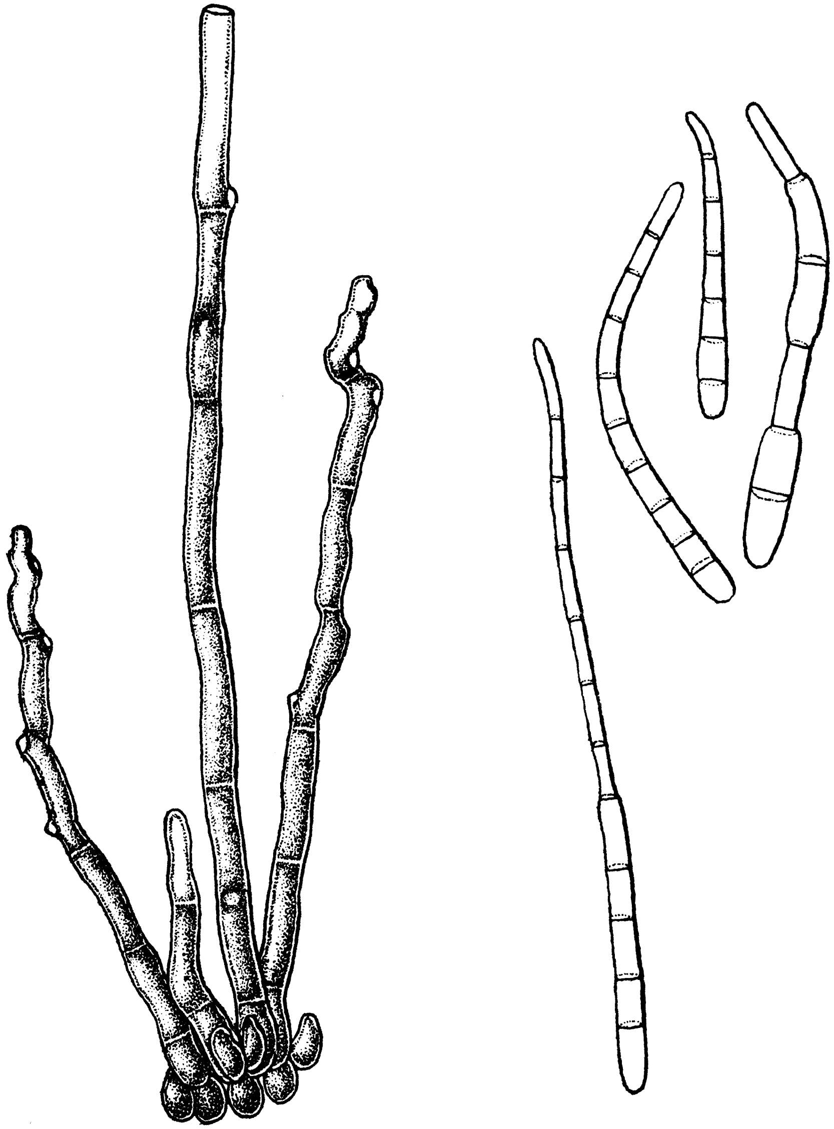

FIG. 2. *Cercospora balsamimae* Mendoza sp. nov.

Conidiis multi-septatis, rotundatis e basi et apice gradatim attenuatis ad apicem, 44 ad 140 μ × 3.5 to 4.5 μ.

Spots amphigenous, irregularly circular to indefinite in form, scattered, oftentimes coalescing, sometimes covering larger areas, sunken, with concentric ring formations in age, light brown at center, dark brown around margin, 1 to 8 mm in diameter, spots often falling off leaving shot holes. Conidiophores in tufts, pale olive-gray becoming pale to almost hyaline toward apex, distant-septate, provided with knees and scars at or near nodes, 60 to 140 μ long, 4 to 5 μ broad. Conidia very long, obclavate, hyaline, sometimes constricted, many-septate, round at base and at apex, gradually tapering toward end, 44 to 140 μ long, 3.5 to 4.5 μ broad.

LUZON, Laguna Province, Los Baños, *Bur. Sci. 55508 Mendoza* (type in Philip. Nat. Herb.), on leaves of *Impatiens balsamina* Linn.

This fungus somewhat resembles *C. atro-cincta* Ell. and Wolf, both having flexuous and reticulate conidiophores. The reticulations are located on the upper portion near the apex. The two fungi are more or less stromatic at the base. They differ, however, in the characteristics of the spores. The conidia of *C. atro-cincta* are larger than those of *C. balsaminae*. Another difference is that the conidia of *C. balsaminae* are often constricted, while those of *C. atro-cincta* are hyaline and simple.

CERCOSPORA CARTHAMI Mendoza sp. nov. Text fig. 3.

Maculis amphigenis, subrotundatis, obscuris brunneis, superne cum griseis olivaceis, 5 ad 10 mm in diametro, interdum confluentis, zona fusca circumdatis, centro depressis. Conidiophoris abundantis, fasciculatis, simplicis, distinctis septatis, pallidis olivaceis ad centrum tandem griseis ad apicem, 38 ad 175 μ × 5 ad 6 μ. Conidiis hyalinis, obclavatis vel cylindraceis, 5- ad 10- septatis, 48 ad 287 μ × 4 ad 6 μ.

Spots amphigenous, somewhat round, dark brown, dotted with little gray freckles, 5 to 10 mm in diameter, sometimes fusing, provided with concentric markings, sunken at center. Conidiophores abundant, in bundles, simple, distinctly-septate, light grayish olive at center, becoming pale smoke-gray toward apex, 38 to 175 μ long, 5 to 6 μ broad. Conidia hyaline, obclavate to cylindric, 5- to 10-septate, 48 to 287 μ long, 4 to 6 μ broad.

LUZON, Rizal Province, Mariquina, *Bur. Sci. 55295* (type in Philip. Nat. Herb.), *55465 Mendoza,* on leaves of *Carthamum tinctorium* Linn.

This species approaches *C. cucurbitae* Ell. and Ev. in many respects. Both have erect and distinctly septate conidiophores, which are blunt at the end. The difference lies in the conidia of *C. cucurbitae* being vacuoled and granular, while those of *C. carthami* are neither.

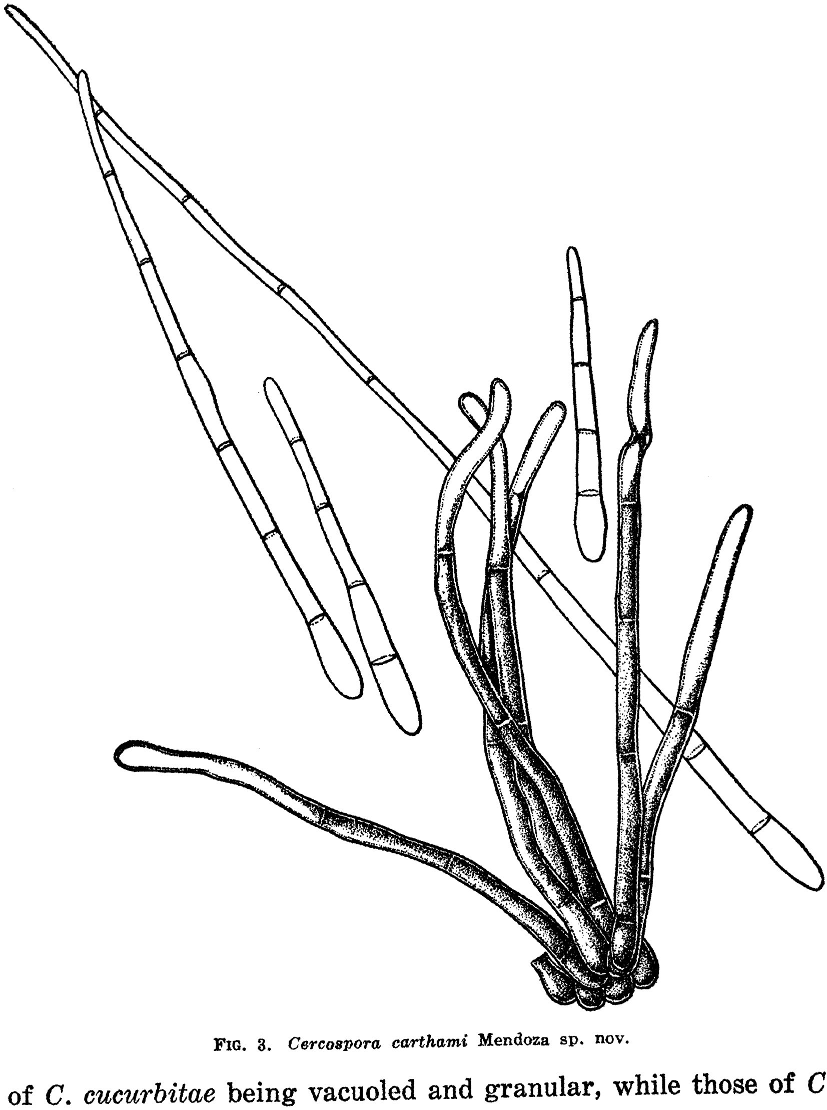

FIG. 3. *Cercospora carthami* Mendoza sp. nov.

CERCOSPORA JACOBINAE Mendoza sp. nov. Text fig. 4.

Maculis amphigenis, sed plerumque plus minusve rotundatis, 3 ad 12 mm in diametro, obscuris brunneis tandem multis albidis ad marginem. Fungus fasciculatus, abundans, amphigenus.

Conidiophoris obscuris olivaceis, e basi stromatica, erectis, flexuus, multi-septatis, subdenticulatis ad vel circa nodo 30 ad 150 μ 3 ad 6.5 μ. Conidiis aciculatis, cylindraceis, saepe curvatis circa apicem, multi-septatis, hyalinis, obclavatis, 30 ad 75 μ × 3 ad 4.5 μ.

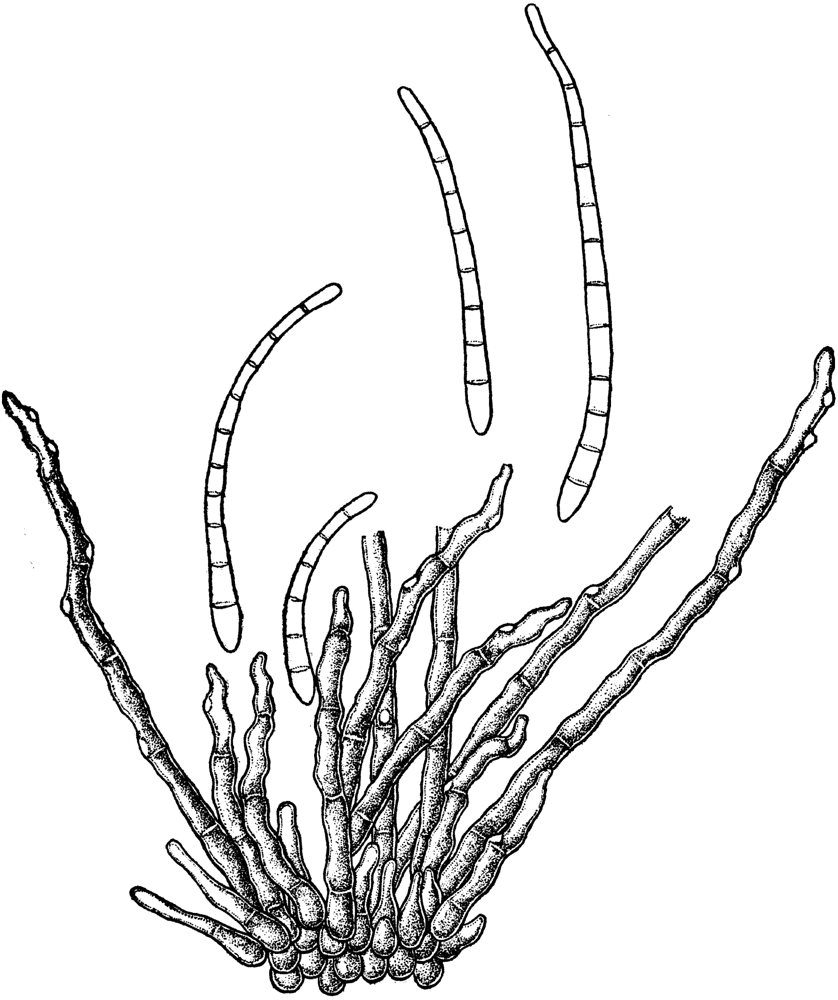

FIG. 4. *Cercospora jacobinae* Mendoza sp. nov.

Spots amphigenous, irregular but generally more or less circular in shape, 3 to 12 mm in diameter, dark brown becoming lighter toward margin. Fungus in tufts, abundant, amphigenous. Condidiophores dark olive, stromatic at base, erect, winding, many-septate, subdenticulate, especially at or near septation, 30 to 150 μ long, 3 to 6.5 μ broad. Conidia needle-shaped,

cylindric, often curved near end, many-septate, hyaline, 30 to 75 μ long, 3 to 4.5 μ broad.

LUZON, Manila, *Philip. Nat. Herb. 7124 Mendoza* (type in Philip. Nat. Herb), on leaves of *Jacobina carnea* Nichols.

At a glance *C. jacobinae* and *C. beticola* Sacc. look alike in many respects, both having flexuous and reticulated conidiophores. The conidia and conidiophores of *C. jacobinae*, however, are larger.

CERCOSPORA MALVASTRI Mendoza sp. nov. Text fig. 5.

Maculis plus minusve circularis, parvis, subdepressis, brunneis vel obscuris brunneis, amphigenis, raro coalescens, genera-

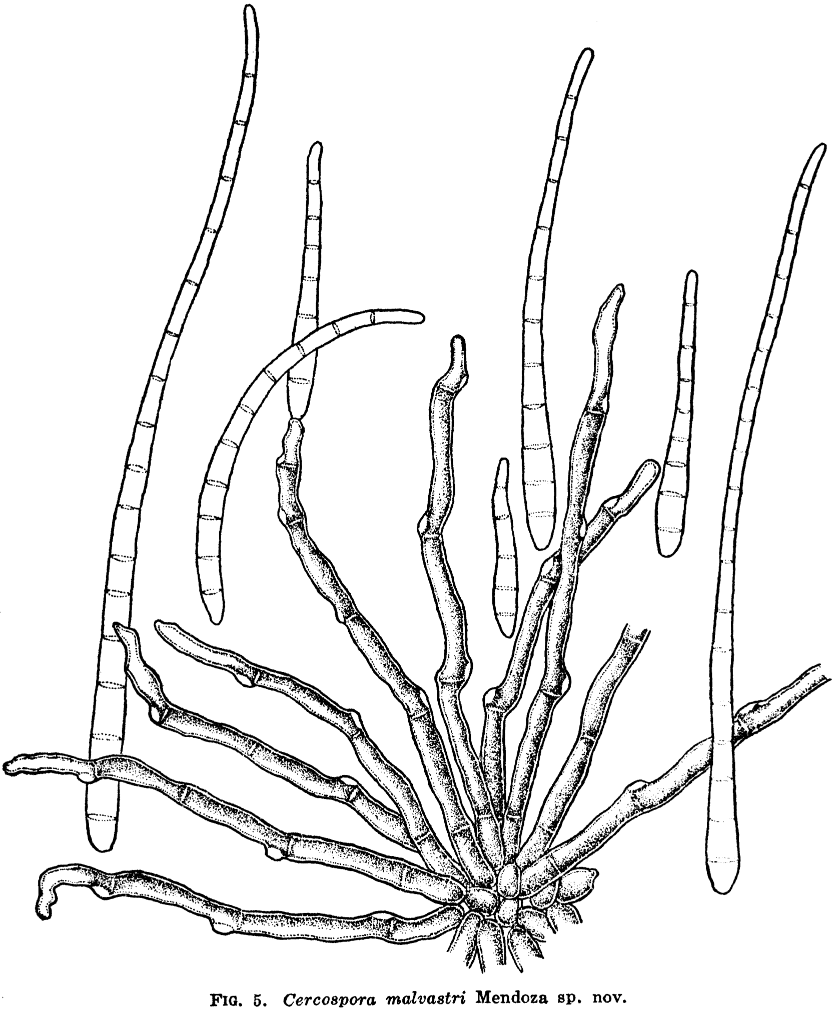

FIG. 5. *Cercospora malvastri* Mendoza sp. nov.

tim minus quam 1 mm ad raro 2 mm in diametro. Conidiophoris numerosis, plus minusve e basi substromatica, pallidis olivaceis, tandem olivaceis ad subhyalinis ad apicem, reticulatis, flexuus, multi-septatis, 18 ad 114 μ × 4.2 ad 5 μ. Conidiis numerosis, hyalinis, aliquot and multi-septatis, obclavatis, non rotundatis ad apicem, subcontractura ad apicem, rectis, interdum curvatis, 18 ad 123 μ × 3 ad 3.6 μ.

Spots more or less circular, small, nearly sunken, brown to dark brown, amphigenous, seldom coalescent, generally less than 1 mm to nearly 2 mm in diameter. Conidiophores numerous, substromatic at base, light olive, becoming pale to nearly hyaline towards end, reticulate, flexuous, many-septate, 18 to 114 μ long, 4.2 to 5 μ broad. Conidia numerous, hyaline, several to many-septate, obclavate, not round at base, somewhat tapering towards end, straight, sometimes curved, 18 to 123 μ long, 3 to 3.6 μ broad.

LUZON, Manila, *Bur. Sci. 55417 Mendoza* (type in Philip. Nat. Herb.), on leaves of *Malvastrum coromandelinum* (Linn.) Gareke.

This fungus resembles *C. capsici* Heald and Wolf in many respects. The conidiophores of the two species are numerous, reticulate, and flexuous. The conidiophores, of *C. capsici*, however, are more winding and much longer than those of *C. malvastri;* also *C. capsici* is more stromatic at the base than *C. malvastri.*

CERCOSPORA MERREMIAE Mendoza sp. nov. Text fig. 6.

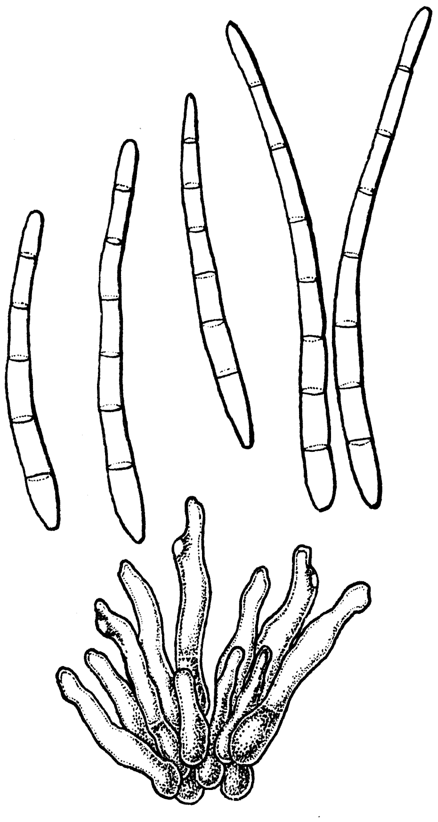

FIG. 6. *Cercospora merremiae* Mendoza sp. nov.

Maculis amphigenis, maxime irregulariter formis, 3 ad 10 mm in diametro, depressis ad centrum dum elevatis ad marginem, obscuris brunneis vel maxime obscuris. Conidiophoris confluentis, pallidis olivaceis, plus minusve e basi stromatica, non- vel 1-septate, reticulatis ad apicem, 15 ad 36 μ × 3 ad 3.6 μ. Conidiis subidem coloris conidiophoris, interdum plus illustris, acicularis vel fuscidis, saepe curvatis, 30 ad 81 μ × 3 ad 4.5 μ.

Spots amphigenous, very irregularly shaped, 3 to 10 mm in diameter, sunken at center, elevated at margin, dark brown to very dark brown. Conidiophores in tufts, pale olive, more or less stromatic at base, 0- to 1-septate, with usual scars near end, 15 to 36 μ long, 3 to 3.6 μ broad. Conidia almost of same color as conidiophores, sometimes lighter, needle-shaped to spindle-shaped, 30 to 81 μ long, 3 to 4.5 μ broad.

LUZON, Manila, *Philip. Nat. Herb. 7122* Mendoza (type in Philip. Nat. Herb.), on leaves of *Merremia gemella* (Burm. f.) Hallier f.

This fungus is somewhat similar to *C. henningsii* Allesch. in many respects. Both species are stromatic at the base. The conidiophores of the two fungi are similar in shape and both are nonseptate, although *C. merremiae* is sometimes 1-septate. The conidia of the two species are similar, being nearly cylindrical. The spores of *C. merremiae,* however, are much larger.

CERCOSPORA MOMORDICAE Mendoza sp. nov. Text fig. 7.

Maculis amphigenis, irregulariter rotundatis vel indefinite formis, disseminatis, depressis, zona fusca circumdatis aetatis, pallidis brunneis in centro, brunneis centrifugalis, 1 ad 12 mm in diametro, saepe maculis confluens formans maxime grandis areae. Conidiophoris fasciculatis vel caespitosis, flexuus, pallidis olivaceis griseis, tandem griseis ad apicem, denticulatis ad vel circa nodis, interdum ramosis, distinctis septatis, 24 ad 127 μ × 4 ad 5 μ. Conidiis maxime longis, interdum ad septa constrictis, hyalinis, multi-septatis, e basi rotundatis, gradatim atenuatis ad apicem, obtusatis e apice, 44 ad 450 μ × 3.5 ad 5.5 μ.

Spots amphigenous, irregularly circular to no definite form, scattered, sunken, with concentric ring formations in age, pale brown at center, brown around margin, 1 to 12 mm in diameter, spots often coalescing to form larger areas. Conidiophores in clusters or in tufts, flexuous, pale olive-gray becoming gray toward apex, provided with knees and scars on or near nodes, sometimes branching, distinctly-septate, 24 to 127 μ long, 4 to 5 μ broad. Conidia very long, obclavate, hyaline, many-septate, sometimes constricted at septa, round at base, tapering toward end, 44 to 450 μ long, 3.5 to 5.5 μ broad.

LUZON, Manila, *Bur. Sci. 55334* (type in Philip. Nat. Herb.), *55372 Mendoza,* on leaves of *Momordica charantia* Linn.

This fungus somewhat resembles *C. beticola* Sacc., both having flexuous and reticulated conidiophores with a slightly stromatic base. The difference lies in that the conidiophores of *C. momordicae* are sometimes branching, while those of *C. beticola* are never branching. The conidia of *C. momordicae* are very much larger than those of *C. beticola.* *C. brassicicola* P. Henn. is another fungus that resembles *C. momordicae,* because of the characteristic reticulation of the conidiophores. The conidiophores of *C. brassicicola,* however, never branch out.

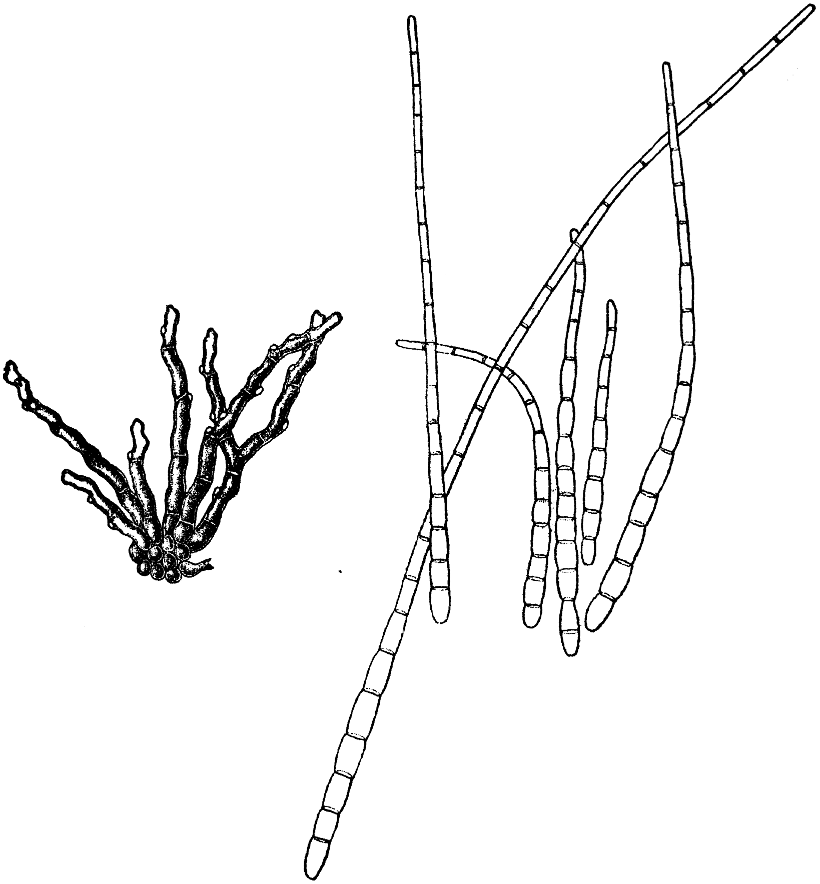

FIG. 7. *Cercospora momordicae* Mendoza sp. nov.

CERCOSPORA OPERCULINAE Mendoza sp. nov. Text fig. 8.

Maculis amphigenis, circularis, pallidis griseis vel viridulis, dispergens, 1 ad 7 mm in diametro. Conidiophoris caespitosis,

fasciculatis, suberectis, reticulatis e superiore parte, septatis, obscuris griseis, tandem pallidis ad apicem, 76.5 ad 109 μ × 3.8 ad 4.5 μ. Conidiis hyalinis, granularis, obclavatis, acicularis, interdum falcatis, multi-septatis, 60 ad 85 μ × 3.5 ad 4.5 μ.

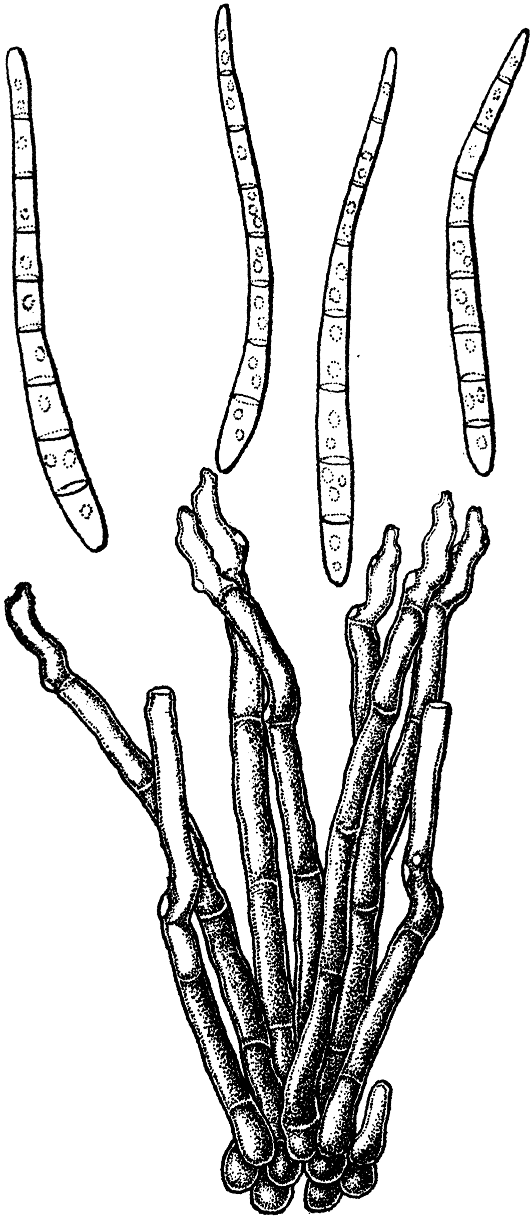

FIG. 8. *Cercospora operculinae* Mendoza sp. nov.

Spots amphigenous, circular, light gray to greenish, scattered, 1 to 7 mm in diameter. Conidiophores cæspitose, fasciculate, nearly erect, reticulate especially on upper portion, septate, dark gray, becoming pale toward end, 76.5 to 109 μ long, 3.8 to 4.5 μ broad. Conidia hyaline, granular, obclavate, needle-shaped, cylindric, sometimes curved, many-septate, 60 to 85 μ long, 3.5 to 4.5 μ broad.

LUZON, Rizal Province, Fort Wm. McKinley, *Phil. Nat. Herb. 7125* (type in Philip. Nat. Herb.), *7126 Mendoza,* on leaves of *Operculina bufalina* (Lour.) Hallier f.

Some characteristics of this fungus are similar to those of *C. jacobinae* Mendoza. Both species have that peculiar winding of the conidiophores, especially on the upper portion near the apex. *C. jacobinae,* however, is more stromatic at the base than *C. operculinae;* also the conidia of this fungus are vacuoled and granular, while those of *C. jacobinae* are hyaline and simple.

CERCOSPORA PELARGONII Mendoza sp. nov. Text fig. 9.

Maculis rotundatis, minimi vel grandis irregularis maculis, amphigenis, depressis, pallidis brunneis ad centro, rubricosis brunneis ad margine, 1 ad 15 mm in diametro. Conidiophoris caespitosis, erectis, reticulatis, flexuus, plus minusve e basi stromatica, aliquot distans-septatis, obscuris olivaceis, tandem pallidis et aculatis ad apicem, 42 ad 96 μ × 3.9 ad 5.7 μ. Conidiis numerosis, obclavatis, fuscidis, interdum curvatis, multi-septatis, hyalinis, obtusatis ad apicem, 24 ad 172 μ × 2.7 ad 3.6 μ.

Spots round, very small to large, almost irregular blotches, amphigenous, sunken, light brown at center, reddish brown at margin, 1 to 15 mm in diameter. Conidiophores in tufts, reticulate, flexuous, more or less stromatic at base, several distant-septate, dark-olive, becoming lighter toward apex and a little pointed at end, 42 to 96 μ long, 3.9 to 5.7 μ broad. Conidia numerous, obclavate, spindle-shaped, sometimes curved, many-septate, hyaline, obtuse on both ends, 24 to 172 μ long, 2.7 to 3.6 μ broad.

LUZON, Manila, *Bur. Sci. 55132* (type in Philip. Nat. Herb.), *55500 Mendoza,* on leaves of *Pelargonium radula* (Cav.) L'Herit.

This fungus resembles *C. beticola* Sacc. in many respects. The conidiophores of the two fungi are cæspitose, fasciculate, flexuous and more or less stromatic at the base. The difference lies in that the conidiophores of *C. pelargonii* are much larger and generally broader. The conidiophores of *C. beticola* are much more winding than those of *C. pelargonii.*

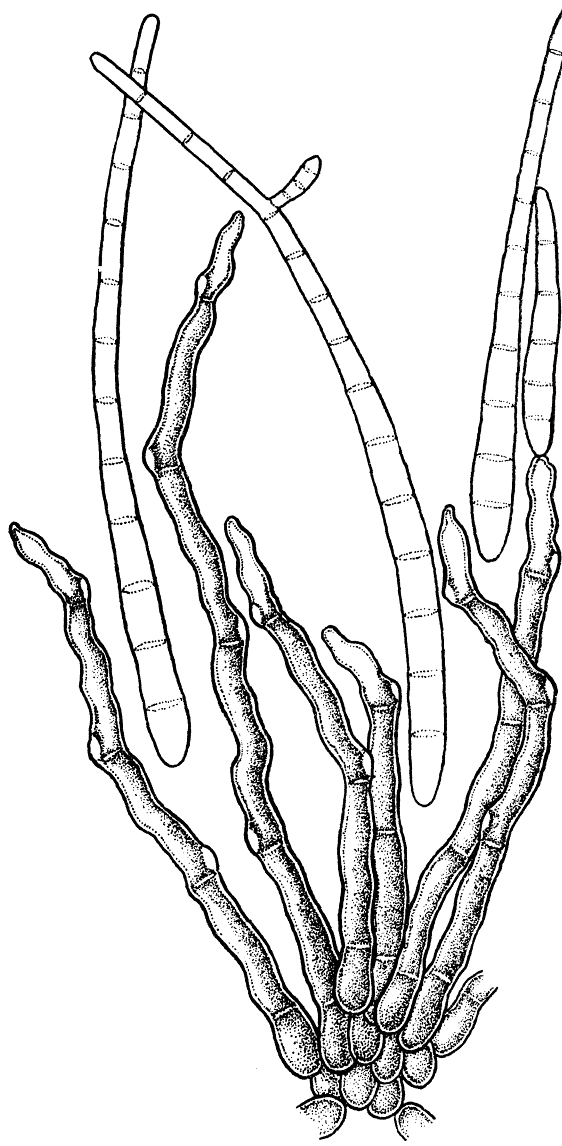

FIG. 9. *Cercospora pelargonii* Mendoza sp. nov.

CERCOSPORA ATRO-CINCTA Heald and Wolf.

Cercospora atro-cincta HEALD and WOLF, Mycologia 3 (1911) 15; SACCARDO, Syll. Fung. 25 (1931) 873.

LUZON, Manila, *Bur. Sci. 55520 Mendoza,* on leaves of *Zinnia elegans* Jacq.

CERCOSPORA ASTERATA Atkinson.

Cercospora asterata ATKINSON, Cerc. Alab. (1891) 18; SACCARDO, Syll. Fung. 10 (1892) 627.

LUZON, Manila, *Bur. Sci. 55502 Mendoza,* on leaves of *Aster* sp.

CERCOSPORA CHRYSANTHEMI Heald and Wolf.

Cercospora chrysanthemi HEALD and WOLF, Mycologia 3 (1911) 15; SACCARDO, Syll. Fung. 25 (1931) 871.

LUZON, Manila, *Bur. Sci. 55522 Mendoza,* on leaves of *Chrysenthemum* sp.

CERCOSPORA CUCURBITAE Ellis and Everhart.

Cercospora cucurbitae ELLIS and EVERHART, Journ. Mycol. 4 (1888) 3; SACCARDO, Syll. Fung. 10 (1892) 634.

LUZON, Manila, *Bur. Sci. 55353, 55494 Mendoza,* on leaves of *Cucurbita pepo* Linn.

CERCOSPORA DALEAE Ellis Kellerman.

Cercospora daleae ELLIS and KELLERMAN, Journ. Mycol. 4 (1888) 6; SACCARDO, Syll. Fung. 10 (1892) 622.

LUZON, Manila, *Philip. Nat. Herb. 2978 Mendoza,* on leaves of *Dalea* sp.

CERCOSPORA EUCALYPTI Cooke and Massee.

Cercospora eucalypti COOKE and MASSEE, Aust. Fungi (1892) 379; SACCARDO, Syll. Fung. 10 (1892) 644.

LUZON, Manila, *Bur. Sci. 55491 Mendoza,* on leaves of *Eucalyptus* sp.

CERCOSPORA HELIANTHI Ellis and Everhart.

Cercospora helianthi ELLIS and EVERHART, Journ. Mycol. 3 (1887) 20; SACCARDO, Syll. Fung. 10 (1892) 628.

LUZON, Mountain Province, Baguio, *Bur. Sci. 55235 Mendoza,* on leaves of *Helianthus cucumerifolius* Torr. and Gray.

CERCOSPORA HYDRANGEANA Tharp.

Cercospora hydrangeana THARP, Myc. 9 (1917) 110.

LUZON, Mountain Province, Baguio, *Bur. Sci. 55236 Mendoza,* on leaves of *Hydrangea ortensia* Sieb.

CERCOSPORA SORGHI Ellis and Everhart.

Cercospora sorghi ELLIS and EVERHART, Journ. Mycol. 5 (1887) 15; SACCARDO, Syll. Fung. 10 (1892) 656.

LUZON, Rizal Province, Mariquina, *Bur. Sci. 55232, 55328 Mendoza,* on leaves of *Zea mays* Linn.

CERCOSPORA PACHYPUS Ellis and Everhart.

Cercospora pachypus ELLIS and EVERHART, Journ. Mycol. 3 (1887) 104; SACCARDO, Syll. Fung. 10 (1892) 628.

LUZON, Mountain Province, Trinidad, *Bur. Sci. 55541 Mendoza,* on leaves of *Helianthus annuus* Linn.

AGARICACEÆ

Genus CANTHARELLUS Jussieu

CANTHARELLUS CINEREUS Fries.

Cantharellus cinereus FRIES, Epicr. Syst. Myc. (1836) 320; Hym. Eur. (1870) 458; SACCARDO, Syll. Fung. 5 (1887) 490; MAUBLANC, Les Champignons de France 2 (1926) 166; BRESADOLA, Icon. Myc. 10 (1927) 480.

LUZON, Tayabas Province, Mount Kamates, *Philip. Nat. Herb. 2882 Edaño:* Rizal Province, Alabang, *Philip. Nat. Herb. 7038 Mendoza:* Laguna Province, Los Baños, *Philip. Nat. Herb. 7054, 7057 Mendoza.*

Genus CLITOCYBE Fries

CLITOCYBE DEALBATA Sowerby.

Clitocybe dealbata SOWERBY in Fries, Epicr. Syst. Myc. (1836) 63. Hym. Eur. (1878) 88; SACCARDO, Syll. Fung. 5 (1887) 157; BRESADOLA; Icon. Myc. 3 (1927) 146.

LUZON, Tayabas Province, Mount Kamates, *Philip. Nat. Herb. 2840 Edaño.*

Genus FLAMMULA Fries

FLAMMULA DECUSSATA Fries.

Flammula decussata FRIES, Epicr. Syst. Myc. (1836) 185; Hym. Eur. (1878) 246; SACCARDO, Syll. Fung. 5 (1887) 816; BRESADOLA, Icon. Myc. 16 (1930) 771.

LUZON, Tayabas Province, Mount Demasengay, *Philip. Nat. Herb. 2888 Edaño.*

Genus MARASMIUS Fries

MARASMIUS FULVO-BULBILLOSUS R. Fries.

Marasmius fulvo-bulbillosus R. FRIES in Bresadola, Icon. Myc. 11 (1929) 501.

Marasmius canticinalis FRIES, Epicr. Syst. Myc. (1836) 536.

LUZON, Laguna Province, Siniloan, *Philip. Nat. Herb. 7120 Capco.*

MARASMIUS OREADES Bolton.

Marasmius oreades BOLTON in Fries, Epicr. Syst. Myc. (1836) 375; Hym. Eur. (1878) 467; SACCARDO, Syll. Fung. 5 (1887) 510; BRESADOLA, Icon. Myc. 10 (1929) 490.

LUZON, Pangasinan Province, Binalonan, *Philip. Nat. Herb. 7061 Mendoza:* Tayabas Province, Mount Biga, *Philip. Nat. Herb. 7118 Edaño.*

Genus OMPHALIA Persoon

OMPHALIA GERARDIANA Peck.

Omphalia gerardiana PECK, N. Y. State Mus. Rept. 26 (1874) 54; 45 (1893) 37; FARLOW, Icones Farlowianae (1929) 4.

LUZON, Tayabas Province, Mount Kamates, *Philip. Nat. Herb. 2847 Edaño.*

OMPHALIA VENTOSA Fries.

Omphalia ventosa FRIES, Epicr. Syst. Myc. (1836) 120; Hym. Eur. (1878) 155; SACCARDO, Syll. Fung. 5 (1887) 309; BRESADOLA, Icon. Myc. 6 (1928) 256.

LUZON, Tayabas Province, Tignoan, *Philip. Nat. Herb. 7109 Edaño.*

Genus PLEUROTUS Fries

PLEUROTUS FUSCUS (Batt.) Bresadola.

Pleurotus fuscus (Batt.) BRESADOLA, Icon. Myc. 6 (1929) 286.

Agaricus eryngii DE CANDOLLE in Fries, Epicr. Syst. Myc. 1 (1836) 84; Hym. Eur. (1878) 171; SACCARDO, Syll. Fung. 5 (1887) 347.

Clitocybe cardarella FRIES, Hym. Eur. (1887) 80.

LUZON, Tayabas Province, Mount Kamates, *Philip. Nat. Herb. 2844 Edaño.*

Genus RUSSULA Persoon

RUSSULA CARNICOLOR Bresadola.

Russula carnicolor BRESADOLA in Rea, Brit. Basid. (1922) 477; Icon. Myc. 9 (1929) 427.

Russula lilacea QUÉLET in Saccardo, Syll. Fung. 5 (1887) 465.

Russula lilacea var. *carnicolor* BRESADOLA in Saccardo, Syll. Fung. 11 (1895) 30.

LUZON, Mountain Province, Baguio, *Philip. Nat. Herb. 2924 Mendoza:* Tayabas Province, Lapit, *Philip. Nat. Herb. 2945 Alcasid and Edaño.*

Genus TUBARIA Smith

TUBARIA FURFURACEA Persoon.

Tubaria furfuracea PERSOON in Fries, Syst. Myc. 1 (1836) 262; Hym. Eur. (1878) 272; COOKE, Handbook of Brit. Fung. Fung. (1871) 136; SACCARDO, Syll. Fung. 5 (1887) 872; BRESADOLA, Icon. Myc. 17 (1930) 816.

LUZON, Tayabas Province, Lapit, *Philip. Nat. Herb. 2944 Alcasid and Edaño:* Manila, Harrison Park, *Philip. Nat. Herb. 7043 Reyes.*

ILLUSTRATIONS

[Drawings prepared by José M. Mendoza.]

TEXT FIGURES

FIG. 1. *Cercospora athyrii* Mendoza sp. nov.
2. *Cercospora balsaminae* Mendoza sp. nov.
3. *Cercospora carthami* Mendoza sp. nov.
4. *Cercospora jacobinae* Mendoza sp. nov.
5. *Cercospora malvastri* Mendoza sp. nov.
6. *Cercospora merremiae* Mendoza sp. nov.
7. *Cercospora momordicae* Mendoza sp. nov.
8. *Cercospora operculinae* Mendoza sp. nov.
9. *Cercospora pelargonii* Mendoza sp. nov.

NOTES ON THE ORCHID BUG, MERTILA MALAYENSIS DISTANT, ON WHITE MARIPOSA (PHALAENOPSIS AMABILIS BLUME)

By SANTIAGO R. CAPCO

Of the Natural History Museum Division, Department of Agriculture and Commerce, Manila

TWO PLATES

Orchid cultivation is now a popular hobby and occupation in the Philippines. Success in the cultivation of orchids depends on various factors. It is known, for example, that certain insects cause considerable damage to orchids. A knowledge, therefore, of some of these destructive insects, and effective methods for their control and eradication, is therefore desirable.

In February, 1940, Dr. E. Quisumbing, of the Natural History Museum Division, received a shipment of orchids (Palawan white mariposa, *Phalaenopsis amabilis* Blume) for Major V. Barros, an orchid fancier. These orchids were placed in the orchid house. A few days later the leaves were turning yellow, drying, and falling off. Careful observations revealed that the plants were badly infested with a capsid bug, *Mertila malayensis* Distant. All stages of the insect, such as eggs, nymphs, and adults, were found among the leaves of the plants in the orchid house.

On account of the severity of infestation, causing great damage to the orchids, a study was undertaken on the life history and habits of this pest, with the ultimate aim of formulating measures for its control.

The study was conducted in the laboratory of the Natural History Museum Division, Department of Agriculture and Commerce, Bureau of Science Building, Manila, from February to May, 1940. Some observations on the habits of the insect were also made in the orchid house of the same institution.

REVIEW OF LITERATURE

Mertila malayensis Distant was originally described by Distant(2) in 1904 from specimens collected by H. N. Ridley in

Singapore, Federated Malay States. In the same year Distant(3) included the description of the genus and the species in his Fauna of British India, Rhynchota. He gave the distribution as Burma, Bhamo, and Singapore.

Roepke(7) described the biology of this insect as a capsid flower bug harmful to orchids (*Phalaenopsis amabilis* Blume and *Vanda* spp.) in Java.

Dammerman(1) gave a short account of the pest, describing it as a pest of orchids, especially *Phalaenopsis amabilis*, and stating that the species has been found from India to Java and introduced into Germany. The eggs are deposited in the plant tissue; nymphs are gregarious, and both nymphs and adults cause damage by sucking the leaves, flower stalks, and roots of the plants, causing the leaves to turn yellow and to fall off. Dammermann suggests collection of the bugs or spraying with soap solution as a means of control.

Leefmans(5) includes this species as a pest of orchids in the Netherland Indies, recommending a spray of derris and soap for effective control.

Franssen and Tiggelovend(4) prepared a short account of the biology of this orchid bug among other orchid pests in Java, giving description, behavior, development, host plants (*Phalaenopsis amabilis, Renanthera matutina,* and species of *Bulbophyllum* and *Vanda*), the nature of the damage done, as well as the means of controlling this insect.

DISTRIBUTION

This insect has been recorded in Singapore (1904), Burma and Bhamo (1904), Java (1918), Netherland Indies (1931), and India (1929), and was reported introduced into Germany.

This pest is reported here for the first time from the Philippines. Damage was especially noted in Manila on white mariposa, *Phalaenopsis amabilis* Blume, collected from Palawan.

MANNER OF INJURY TO ORCHIDS

Injury to the orchid plants is due to the feeding and oviposition punctures made by the insect (Plate 1). The adults and nymphs suck the juice of the leaves, peduncles, and the roots. Young and old leaves of *Phalaenopsis amabilis* have been observed to be attacked by the bugs. The nymphs, on account of their gregarious habit, have been able to do great damage within a few days. Infestation is easily noticeable on both surfaces of the leaves, the feeding punctures appearing as creamy-white spots that later become yellow; excreta of the bugs are also present in the form of numerous black specks. Seriously injured leaves dry up and fall off. Affected roots and peduncles also show signs of drying.

Injury to the orchid plant is done also by the oviposition of the eggs inside the leaves (Plate 2, fig. 1). In laying, the female inserts the eggs beneath the epidermis of the leaf, thus destroying the chlorophyllous cells in that area.

Moreover, the injuries resulting from oviposition punctures and the sucking of the juice in the leaves by the nymphs and adults may serve as possible avenues for the entry of disease organisms.

BIOLOGY

Eggs, nymphs, and adults were collected from infested white mariposa (*Phalaenopsis amabilis* Blume) in the orchid house and reared in the laboratory. The eggs inside the tissues of the leaves were cultured in petri dishes 10 centimeters in diameter and 1.5 centimeters high. Moist cotton was provided inside each dish. Nymphs and adults were reared separately in battery jars 18 by 12 centimeters, provided with fresh leaf of *Phalaenopsis amabilis*. The battery jars were covered with cheese cloth. Individual rearing of the bug was done in glass vials 80 by 25 millimeters with absorbent cotton plugs. The feed was changed daily or once every two days. Observations were made also on adults pairs in glass vials.

The habits of the insect were also observed in the orchid house.

ADULTS

Description.—Elongate-oval (Plate 2, fig. 5); head rather long, depressed in front of insertion of antennæ. Antennæ with first segment shorter than head and generally tapering at base, second segment much longer than first, remaining segments pilose; pronotum about one and one-half times as long as broad, with an anterior collar which has its anterior and posterior margins carinate, subimpressed or distinctly constricted before middle, the depression having two transverse callosities with a little hallow area between them, surface of posterior two-thirds densely and finely punctate; scutellum small, subtriangular, callous, foveate near base; hemelytra much longer than abdomen, membranal cell long, triangular; legs moderately short and slender, tibiæ finely setose, apical joint of tarsi incrassate; upper surface very finely and obscurely pilose.

Orange-red; apex of first joint of antennæ, legs, apex of rostrum, membrane, extreme apices of femora, tibiæ, tarsi, and abdomen beneath indigo black; posterior half of clavus, corium (excluding basal area) and cuneus shiny blue-black; basal half of third joint of antennæ creamy-yellow.

Male, length, 4.8 to 5.6 millimeters; width, 2.1 to 2.3. Female, length, 5 to 5.6 millimeters; width, 2.2 to 2.4.

The sexes are easily distinguished by differences in the ventral caudal end of the abdomen; in the male (Plate 2, fig. 6) there are present a pair of long, coiled genital claspers, while the female (Plate 2, fig. 7) has an ovipositor held close to the abdomen when not in use.

Habits.—Observations were made on five pairs of adult bugs in the laboratory from their emergence to death. The insect was so voracious that a number of orchid plants were almost defoliated during the progress of the rearings, and the food supply was therefore a major problem.

Mating was observed to take place mostly during the early part of the day. It was accomplished by the male mounting on the female, the pair then remaining with the ends of their abdomina together for several hours. Their heads were in opposite directions. The bugs were able to feed while in copula.

The eggs were laid by means of inserting the ovipositors of the females beneath the epidermis of the leaves parallel to the veins. The females mostly laid their eggs on the lower surface of the leaves. Each egg had the smaller end reaching the lower surface of the leaf and was provided with a pasty cover which dried later. After laying the eggs the female secreted a white fluid through the anus and then spread it by means of her rostrum. This white fluid soon dried and covered all the eggs deposited. In this way it was easy to locate the spot where the insect laid the eggs

As shown in Table 1, each female makes one to four or six egg spots a day. The number of eggs laid on each egg spot was one to five or eight. Each female laid one or two to ten or twelve eggs a day. The average was five eggs a day.

The number of laying days was observed to be from 21 to 23. The total number of egg spots made during the laying period was from 49 to 73. The total number of eggs laid was from 81 to 135.

TABLE 1.—*Egg-laying data of five females of Mertila malayensis.*

Culture number.	Laying days.	Total number of egg spots.	Egg spots made daily.			Total number of eggs laid.	Number of eggs per egg spot.			Number of eggs laid daily.		
			Min.	*Max.*	*Ave.*		*Min.*	*Max.*	*Ave.*	*Min.*	*Max.*	*Ave.*
1	21	59	1	6	3	104	1	6	2	1	12	5
2	23	73	1	6	3	135	1	6	2	1	12	6
3	21	49	1	5	2	101	1	6	2	2	10	5
4	23	42	1	4	2	81	1	8	2	1	10	4
5	22	63	1	6	3	121	1	5	2	1	12	5
Average	22	57.2	1	5.4	2.6	108	1	6	2	1	11	5

TABLE 2.—*Longevity of adult Mertila mayalensis, based on five males and five females.*

Culture number.	Emerged.	Died.	Duration.
MALES	*March, 1940*	*1940*	*Days.*
1	7	March 31	24
2	8	April 13	36
3	8	April 8	31
4	10	April 6	27
5	10	April 12	33
Average			30.2
FEMALES			
1	6	April 6	31
2	8	April 15	38
3	8	April 10	33
4	10	April 16	37
5	10	April 12	33
Average			34.4

The longevity of the five males and five females is shown in Table 2. After emergence the adult males were observed to live from 24 to 36 days, and the adult females, from 31 to 38 days. According to Franssen and Tiggelovend (4) the adult bugs live for about 2 months in Java.

EGGS AND NYMPHS

The egg is ellipsoidal, slightly curved towards the smaller end (Plate 2, fig. 2). It is glistening light yellow, 1.1 millimeters long and 0.25 millimeters wide. The color turns to rose when the egg is about to hatch.

The young nymph is ovoid, 1.2 millimeters long and 0.3 millimeter wide (Plate 2, fig. 3), rose-colored, with light-colored, slender antennæ and legs.

The old nymph is also ovoid, 4 by 2 millimeters, and brick-red (Plate 2, fig. 4). The ventral side of the abdomen is lighter; the legs and antennæ are yellow; the eyes are red. The wing pads are prominent.

The nymphs are active and gregarious. When disturbed they scatter and hide on the opposite side of the leaf and among the roots of the plants.

LENGTH OF LIFE CYCLE

Data on the life cycle of the 25 orchid bugs that were successfully reared in the laboratory are given in Table 3. The incubation period of the eggs ranges from 15 to 16 days, with a mean of 15.5 ± 0.1012 days. There are five nymphal instars. The duration of the first instar ranges from 3 to 4 days, with a mean of 3.2 ± 0.0592 days; the second instar, 3 to 4 days, with a mean of 3.5 ± 0.1012 days; the third instar, 3 to 4 days, with a mean of 3.3 ± 0.0917 days; the fourth instar, 4 to 5 days, with a mean of 4.2 ± 0.0876 days; and the fifth instar, 5 to 6 days, with a mean of 5.3 ± 0.0953 days. The pupal period was observed to range from 18 to 21 days, with a mean of 19.6 ±0.1426 days.

TABLE 3.—*Life cycle of the orchid bug, Mertila malayensis Distant.*

Stage.	Number of cultures.	Duration in days.				
		Minimum.	Maximum.	Mean.	Standard error.	Standard deviation.
Incubation period	25	15	16	15.5	0.1012	0.5063
First instar	25	3	4	3.2	0.0592	0.2962
Second instar	25	3	4	3.5	0.1012	0.5063
Third instar	25	3	4	3.3	0.0917	0.4587
Fourth instar	25	4	5	4.2	0.0876	0.4378
Fifth instar	25	5	6	5.3	0.0953	0.4766
Nymphal period	25	18	21	19.6	0.1426	0.7130
Egg to adult	25	33	37	35.0	0.1780	0.8898
Emergence to egg laying	15	6	12	8.4	0.4451	1.7237
Life cycle (egg to egg)	15	41	46	43.7	0.3472	1.3457

In Java, according to Franssen and Tiggelovend(4) the duration of the egg stage is not known and the nymphal period lasts about 4 weeks.

The period from the laying of the egg to the emergence of the adult lasts from 33 to 37 days, with a mean of 35 ± 0.178 days. Among the emerging adults were 10 males and 15 females. The 15 adult females began to lay eggs from 6 to 12 days after emergence, with a mean of 8.4 ± 0.4451 days. The total life cycle of the females was observed to be from 41 to 46 days, with a mean of 43.7 ± 0.3472 days.

SUGGESTIONS ON MEANS OF CONTROL

The following suggestions are submitted as means of controlling the orchid bug, *Mertila malayensis*:

1. Collecting and destroying the eggs, nymphs, and adults when present on the orchid plants.

2. Spraying or dipping the orchid plants in insecticide solutions, such as soap, nicotine sulphate, derris, and pyrethrum compound.

Ordinary laundry soap at the rate of 4 to 6 grams per liter of water is effective as contact spray.

Tobacco decoction prepared by boiling 100 grams of tobacco waste (cut stems and leaves) in a liter of water for about 30 minutes may be used, 1 part in 4 to 6 parts of water. Nicotine sulphate, a concentrated tobacco extract, may be used as spray, 1 part mixed with 700 to 800 parts of water.

Derris powder which contains about 3 to 4 per cent rotenone is also effective at 2 to 6 grams per liter of water. Pyrethrum compound may be used like derris powder, at 2 to 5 grams per liter of water.

Any of the above-mentioned insecticides will be more effective if mixed with soap solution in the proportions given.

3. Orchid plants should be kept in well-screened orchid houses in order to protect them from the attack of this destructive pest.

4. Newly collected or bought orchid plants should be segregated and examined for the presence of this pest, which is often carried with the host plants. It is important that these plants be immersed once a week in any of the above solutions until all the pests harbored by them are killed.

SUMMARY AND CONCLUSIONS

1. *Mertila malayensis* Distant is a capsid bug pest of orchids, especially *Phalaenopsis amabilis*. It attacks leaves, peduncles, and roots of orchid plants, causing great damage.

2. The species has been reported from Singapore, Burma, Bhamo, Java, Netherland Indies, and India, and has been introduced into Germany. This pest is reported for the first time in the Philippines.

3. The bugs injure the orchid plants by means of feeding and oviposition punctures. The badly infested leaves dry up and fall off.

4. The adult bugs are described. Mating takes place during the early part of the day and lasts for several hours.

5. Observations on egg-laying are given. Eggs are laid in the tissues of the leaves, parallel to the veins, either singly or in groups of from 5 to 8 eggs in an egg spot. A female makes from 1 to 6 egg spots a day and makes a total of 49 to 73 egg spots during her laying period. Each female lays from 1 to 12 eggs a day. The total number of eggs laid by each female is 81 to 135. The males live 24 to 36 days, and the females 31 to 38 days.

6. The egg and the young and old nymphs are described. The nymphs are very active and gregarious.

7. The incubation period of eggs lasts from 15 to 16 days, with a mean of 15.5 ± 0.1012 days. There are five nymphal instars; the nymphal period lasts from 18 to 21 days, with a mean of 19.6 ± 0.1426 days. The length of the life cycle as observed in the laboratory is 41 to 46 days, with a mean of 43.7 ± 0.3472 days.

8. Suggestions on means of control are included, as collecting and destroying the pest; spraying or dipping the infested orchid plants in soap, nicotine, sulphate, or derris solution, or pyrethrum compound. Screening orchid houses gives good protection to orchids from the attack of the pest, and newly acquired plants should be segregated and immersed in insecticide solution in order to kill all pests harboring on them.

ACKNOWLEDGMENT

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LITERATURE CITED

1. DAMMERMAN, K. W. The agricultural zoology of the Malay archipelago. J. H. de Bussy Ltd. Amsterdam (1929) vii + 479 pp., 40 pls. 179 figs.
2. DISTANT, W. L. Rhynchota notes. XX. Ann. Nat. His. VII 13 (1904) 103–114.
3. DISTANT, W. L. The fauna of British India including Ceylon and Burma, Rhynchota (Heteroptera). Taylor and Francis. London 2 (1904) xvii + 503 pp., 319 figs.

4. **Franssen, C. J.**, and **L. M. J. Tiggelovend.** De vijanden en ziekten van de orchideen op Java en hunne bestrijding. G. Kolff. & C. Batavia Centrum (1935) 1–84.
5. **Leefmans, S.** De thans bekende ziekten en plagen van orchideen in Netherlandsch Indie en hare bestrijding. Bandoeng, N. V. Mij. Vorkink (1931) 1–24, 12 figs. Cited in Rev. Appl. Ent. Ser. A **20** (1932) 249.
6. **Merino, G.**, and **F. Q. Otanes.** Control of insects and other pests. Philip. Journ. Agric. **8** (1937) 437–462, 12 pls.
7. **Roepke, W.** Mertila malayensis Dist. een bloemwants (Capsid) schadelijk voon orchideen. Taysmannia (1918) 201–212, figs. 1–9.

ILLUSTRATIONS

[The drawings were prepared by illustrators of the National History Museum Division.]

PLATE 1

Orchid plants (*Phalaenopsis amabilis* Blume) showing damage done by orchid bugs. Fig. 1, plants in the early stage of infestation; *2*, badly damaged plants. × ¼.

PLATE 2

FIG. 1. A lower portion of an orchid (*Phalaenopsis amabilis* Blume) leaf showing deposited eggs, × 2; *2*, egg, × 35; *3*, young nymph, dorsal view, × 20; *4*, old nymph, dorsal view, × 10; *5*, adult bug, dorsal view, × 8; *6*, caudal end of adult male abdomen, ventral view, × 10; *7*, caudal end of adult female abdomen, ventral view, × 10.

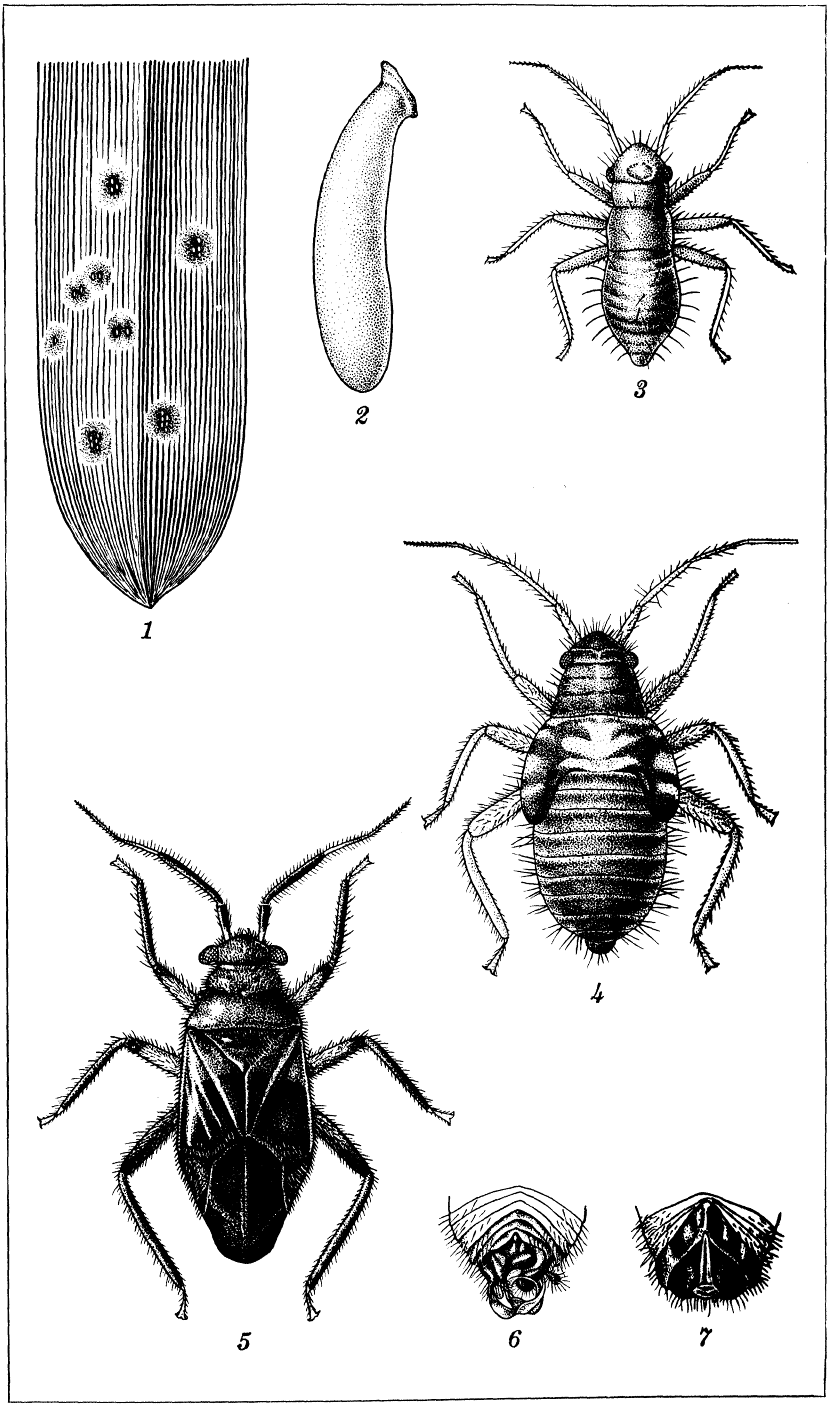

PLATE 1.

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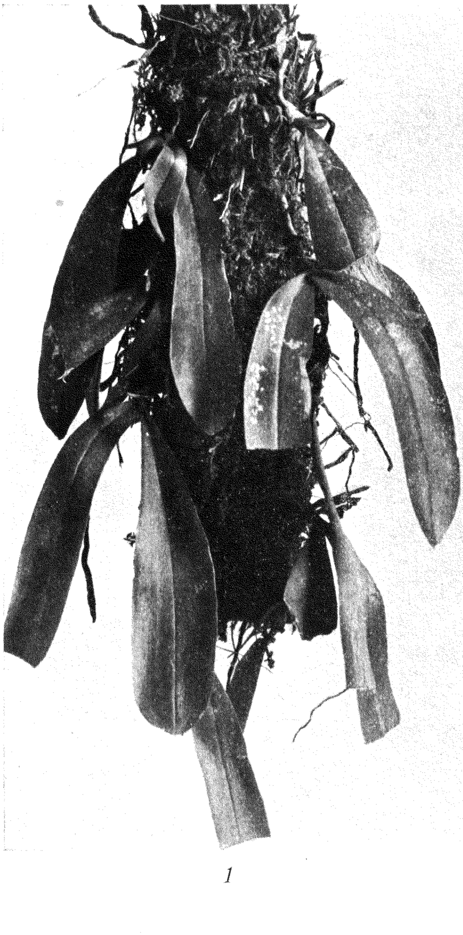

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PLATE 2.

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SUPPLEMENTARY NOTES ON THE ILOKO VERB

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MOODS AND TENSES

I. 1. The present and past tenses have been studied with each prefix, infix, and suffix, which have ordinarily two forms, one for the present and one for the past.

2. The past is often indicated, besides, by the use of the conjunction *idí*, 'when,' or of the adverbs of time referring to the past. Examples:

idí immáyak	when I came.
idí panagáladda	when they made the fence.
idí pannakabáutna	when he was whipped.
idí ipapatáyna	when he died.
idí kalmán ti yaáyna	he came yesterday.
simmañgpét idí malém	he arrived yesterday afternoon.
itáy ti panagságadmi	we swept it just now.
itáy bigát ti pannakasárakmi kenkuána	we found him this morning.

3. When the past tense has to be emphasized, or when it can be inferred neither from the form of the verb nor from the construction of the sentence, the Iloko put the adverb *itáy* or *idí* after the verb. Examples:

napán idí	he went formely.
nagsáñgitak idí	I wept formerly.
nagpilpílayak idí	I was limping at the time.
siká idí	was it you?
nasiñgpét idí	he was good.
gayyémko idí	he was my friend.
addá idí	there was some.
awán idí	he was not there.
managíbit idí	he wept very much.
napalálo itáy	it was too much.
dakayó itáy	was it you?
kaaróbami itáy	they were our neighbors.
addá itáy	he was here.

II. The imperative is not distinguished from the present in affirmative sentences; in negative sentences, however, the adverb of negation *di* is often preferred to *saán.* Examples:

mapánka	go.
ínkayo	go.
agsáñgitka	weep.
agkatáwakayo	laugh.
díka mapán	don't go.
díkayo matúrog	don't sleep.
díka aláen	don't take it.
díkay isañgpét	don't bring it in.
saánka a mapán	you don't go (or, don't go; or, you shall not go).

III. The future is indicated by:

1. The conjunctions: *intóno, no* (ordinary forms), *tóno, attóno,* (rarely used); they are followed by a verb in the present. Examples:

intóno umáy	when he shall come.
intón awán ti táo	when there is nobody.
intóno agpabáut agtaráykami	when he has us whipped we shall run away.
baútek no umáy	I shall whip him when he comes.
aláek no sumañgpét	I shall take it when he arrives.
tóno mayát gatáñgek	I shall buy it when he is willing.
attóno pumánaw	when he goes away.
antón addá	when he is there.

2. The interrogatives: *intonanó* (ordinary form), *no anó, tonanó, attonanó, antonanó* (rarely used). Examples:

intonanó ti yaáyna	when does he come?
intonanó ti panañgyégyo	when do you bring it?
intonanó ti panagsáñgityo	when do you weep?
intonanó ti pannatúrogmo	when do you sleep?
no anó ti panagálayo	when do you take it?
tonanó ti panagpandilíñgna	when will she wear skirts?
attonanó ti kayátna a maarámid	when does he want it done?
antonanó ti panagsúratmo	when do you write?

3. The adverbs of time referring to the future. Examples:

umáyak no bigát	I shall come tomorrow.
intóno malém ti panagsarítana	he will talk this afternoon.
intóno rabíi ti yaáymo	come this evening.
mapánda rabíi no bigát	they will go tomorrow evening.
ínka bigát no bigát	go tomorrow morning.

4. The addition of the adverb *to* to one of the words of the clause intimating the future, ordinarily and more correctly to

the first word. When the adverb *to* is joined to a word ending in a vowel, the ligature *n* connects the two. Examples:

mapánakto	I shall go.
aláemto	you will take it.
mayátakto no mayát ti kabsátko	I shall be willing when my brother is willing.
bagásto ti gatáñgenda	they will buy rice.
saganáenminto	we shall prepare it.
sagádanyonto	you will sweep it.
sikánto ti ayabák	I shall call you.
ínkanto mañgála ti págay idiáy Bantáy	you will go to get rice at Bantay.
napigsánto ti kabáyom	your horse will be strong.
tínto umáwat	the one who will receive.
aniánto ti dawátek	what shall I ask?
itédkonto kenká úrayto pay ti gudduá ti pagariák	I shall give it to you even though it were one half of my kingdom.
dídanto maramanán ni rígaten	they will not taste hardship henceforth.

NOTE 1. The Iloko know, however, that the future is always uncertain, and therefore, when they want to express an event that will certainly take place, excluding all possibility of doubt, they use the present form without the adverb *to*. For example, *umáyto*, he will come, still including the possibility of his not coming; *umáy*, he shall come, without any doubt. In this case, the context must show what tense is really intended, the present or the future; the adverb *en*, for example, would make the verb conclusively present: *umáyen*, he is coming, he comes already.

IV. To indicate that something happens after something else, the action which is last in time is introduced by the conjunction *sa*. The peculiarities connected with the use of the possessives when *sa* is followed by a substantive or a substantival verb, have been alluded to before.[1]

1. The simple conjunction *sa:*

a. When both clauses are in the past. Examples:

immáy ti lakáy sa pimmánaw ti bakét	the old man came and then the old woman went away.
nañgála ití bagás sána inláko	he took rice and then sold it.
nagtaráy ti áso sa natáy	the dog ran and died.
nagsáñgit ti ubíñg sáda binaút	the child wept and they whipped him.
pimmídut ti kaaróbami sákam indarúm	our neighbor stole and we sued him.
intaráyna sána inasáwa	he eloped with her and then married her.
inbátina sa nagbabáwi	he left it and then repented.

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[1] The Pronoun. II. Possessives, 2. Pecularities, 1. Anthropos 28 (1933) 691.

b. When both clauses are in the present. Examples:

umáyka sáak mapán	come and I shall go.
mañgálaka ití págay sáda mayát	take rice and they will be willing.
sumañgpétda sákam mañgála	let them arrive before we take some.
bumassít sa umadú	it decreases and then increases.
agásan ti gayyémko sa umimbág ti masakít	my friend treats him and the sick person gets well.
gatáñgenda sáda iláko	they buy it and then sell it.
agkatáwakami sákay ipagél	we laugh and you forbid it.
mayátka sádaka gayyém	be willing and you shall be our friend.

c. When the first clause is in the past, the second in the present. Examples:

nagsáñgit idí kalmán sána dawáten manén	he wept yesterday and now asks for it again.
inlákona sána paisublí	he sold it and now wants it back.
nagtaráyka sáka umáy ditóy	you ran and now come here.
inálana sa aguñgét	he took it and now is angry.
mayát pay idí sa madí itá	he was still willing at the time and now refuses.

2. The conjunction *sa* combined with the adverb *to,* when the second clause is in the future. Examples:

birókem ti napúkawmo sákanto mañgála ití kaném	look for what you lost and then take your food.
kitáem no addá sádanto agrubbuát	look if he is there and then they shall start.
agsáñgitkayo sádakayonto baúten	weep and they will whip you.
taraknném daytóy sákamto ibílañg ñga anákmi	bring this one up and we shall adopt him.
sumápulka sákanto sumakdó	look for some and then draw water.
umimbág pay sánto mabalín	let him first get well and then it will be allowed.
saán a mapán sánto magongonaán	if he does not go he will be rewarded.
aláenna sánanto lutoén	he takes it and then he will cook it.
inálana idí kalmán sánanto isublí no bigát	he took it yesterday and he will return it tomorrow.
nañgán itáy sánto dumáwat manén	he ate just now and then he will ask for it again.
nagkatáwa itáy bigát sánanto ibabáwi no malém	he laughed this morning and he will repent this afternoon.
ginátañgmi ti káyo sákamto agpatakdér ití baláy	we bought timber and then we shall build a house.

V. The conditional is indicated by the conjunction *no* and the adverb *komá;* the verb is either in the present or in the past.

1. Conditional clause: either *no komá no* introduces it, or *no* introduces it and *komá* follows the first word or words.
2. Principal clause: *komá* follows the first word or words; sometimes, however, it is dropped. Examples:

no komá no nasin͠gpét ti ubín͠g gongonaánmi komá	if the child were virtuous, we should reward him.
no komá no addá idiáy payégmi komá ditóy	if it were there, we should bring it here.
no komá no saán a rabíi ínkam komá agay-áyam	if it were not evening, we should go to play.
no komá no addá ásomi índa komá man͠ganúp	If we had a dog, they would go hunting.
no komá no suman͠gpét ti ubín͠g awán komá ti pambáryo	if the child would arrive, you would have no excuse.
no komá no basáentayo ti súrat ammótay komá ti ipadámagna	if we read the letter, we should know what he announces.
no komá no ginátan͠gda ti suká naímas komá ti sidá	if they had bought vinegar, the food would be palatable.
no komá no immáy ti gayyémko idí kalmán siák ti mapán no bigát	if my friend had come yesterday, I should go tomorrow.
no komá no saánda a nagsán͠git saántay komá a sinaplít	if they had not wept, we should not have whipped them.
no komá no nalpás ti baláyna saánna komá a ginátan͠g daydí maysa	if his house had been finished, he would not have bought that other one.
no komá no immáy ti lakáy napánkami komá	if the old man had come, we should have gone.
no mapán komá ti kabsátmi agnanaédda komá ditóy	if our brother would go, they would stop here.
no nalukmég komá ti anákko díak komá madanágan	if my child were fat, I should not be worried.
no saánka komá a nasadút aramídem komá ti baláymo	if you were not lazy, you would make yourself a house.
no adú komá ti bagás baknán͠gda komá	if there were much rice, they would be rich.
no awán komá ti pagpeggadán ínkam komá idiáy	if there were no danger, we should go there.
no naimbágkayo komá n͠ga ubbín͠g adú komá ti kúkuayo	if you were good children, you would have much property.
no ilákona komá ti baláyna gatán͠genmi komá	if he sold his house, we should buy it.
no inasáwana komá ti balásan͠gko díak komá rebbén͠g ti agpalpalamá	if he had married my daughter, I should not be obliged to beg.
no nan͠gála komá ti kaaróbayo kadagití alikámenna saánna komá a rebbén͠g ti bumúlod	if your neighbor had taken his furniture, he would not be obliged to borrow things.
no binantáyanna komá ti págaymi saán komá a kinnán ti bábuy	if he had watched our rice, the pigs would not have eaten it.

VI. The subjunctive is indicated by the adverb *komá* placed after the first word or words of the sentence. Examples:

man͠gála komá	he should take some.
birókem komá	you should look for it.
isú komá ti aramídenna	that is what he should do.
awán komá ti ásoda	they should have no dog.
siká komá ti mapán	you should go.
mabalín komá	it should be possible.
ibáonmo komá ití baláy	you should send it to the house.
simman͠gpét komá ti anákko	my son should have come home.
ginátan͠gmi komá ti baláyda	we should have bought their house.
ti komá púsa ti inálam	you should have taken the cat.
ni komá Pédro ti nan͠gbaón kaniák	Peter should have sent me.

VII. The optative is indicated by the conjunctions: *sápay* (*komá*) *ta, sápay* (*komá*) . . . *ta, sápay* (*komá*) *no, sápay* (*komá*) . . . *no, napiá* (*komá*) *no, námak* (*kad*) *komá no, naimbág* (*komá*) *no,* and other ordinary forms, and the rarely used forms *aman͠gán no . . . komá, n͠gáman ta . . . komá.* The verb is either in the present or in the past. Examples:

sápay komá ta awán idiáy	I wish he were not there.
sápay komá ta ilákona ti masápulmi	I wish he sold what we need.
sápay komá ta makabírok ití ásomi	I wish he might find our dog.
sápay komá ta ginátan͠gna ti baláy	I wish he had bought the house.
sápay ta yégna a dágus	I wish he brought it at once.
sápay komá ití Diós ta mapánda	would God they went.
sápay ken apó Diós ta suman͠gpét	would God he arrived.
sápay komá no makaálakami	I wish we could take some.
sápay no makapagnáak	I would I could walk.
sápay komá ití Diós no umdás ti kanénmi	would God we had enough food.
sápay ití Diós no maipabúlodda	would God they allowed us to borrow it.
napiá komá no awán ti nagsakít	all right if there were no sick people.
napiá pay no agyánka komá ditóy	it would be better if you stayed here.
námak kad komá no umáyda itá	I would they came now.
námak komá no makaruárka	I would you passed your examination.
naimbág komá no awán ti madí	it were all right if nobody refused.
naimbág no mayát	all right if he is willing.
di pay naimbág komá no awán ti matáy kadatayó	would it not be lovely if none of us died?
nasayáat komá no madí	I wish he refused.
nasayáat no addá	all right if he is there.
aman͠gán no matáyak komá gapó kenká	I wish I might die for you.
n͠gáman ta addá komá agláko	I would some people sold it.
n͠gáman ta nagsúratak komá idí	I would I had written before.

VIII. The infinitive and the present participle, as we understand them in English, are rendered into Iloko by a verb connected with a substantive, a predicate or another verb, either immediately or by a ligature.

1. Infinitive:

a. A verb connected with an auxiliary (no ligature). *See* Auxiliaries.[2] Examples:

napán nan͠gála	he went to take some.
napánna ginátan͠g	he went to buy it.
ínna aláen	he goes to take it.
immáy simmakdó	she came to draw water.

b. An adjectival verb connected with a predicate by the ligature *ti.* *See* The Ligature *ti* (2).[3] Examples:

naimbág ti aginaná	it is good to rest.
nakaay-ayát ti agay-áyam	it is lovable to play.
dákes ti agtákaw	it is bad to steal.

c. An adjectival verb connected with a substantival verb by the ligature *ti.* *See* The Ligature *ti* (3).[4] Examples:

kayátko ti mapán	I want to go.
ammóna ti agbása	he knows how to read.
kayátmi ti agádal	we want to learn.
mabalínko ti agikkís	I can shout.

d. A substantival verb connected with a substantive by the ligature *a* or *n͠ga.* *See* The Ligature *a* or *n͠ga* (II, B, 8).[5] Examples:

annón͠g a saán a tun͠gpálen	a duty not to be complied with.
rebbén͠g a lualoén	one should recite the prayer (literally: a duty to recite the prayer).
táo n͠ga ayatén	a man to be loved.

e. A substantival verb connected with a predicate by the ligature *a* or *n͠ga.* *See* The Ligature *a* or *n͠ga* (II, B, 8).[6] Examples:

dákes n͠ga inumén	it is bad to drink it.
nakaskasdáaw a kitkitáen	it is wonderful to behold.
dákes a di patién ti saóna	it is bad not to believe his words.
naalás n͠ga isúrat	it is bad taste to write it.
narígat a baonén	it is hard to send him.
dákes n͠ga aramíden	it is bad to do it.
maikarí n͠ga annugóten ti naganák kadatáo	our parents are worthy to be obeyed.

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[2] Page 205.
[3] Unpublished.
[4] Ibid.
[5] Ibid.
[6] Ibid.

f. A substantival verb connected with another substantival verb by the ligature *a* or *ñga*. *See* The Ligature *a* or *ñga* (II, B, 11).[7] Examples:

ammóm ñga inornóñg	you knew how to gather them.
ammóm ñga inilalá	you knew how to take good care of it.
kayátko ñga aláen	I want to take it.
itédna ñga ipainúm	he gives it to drink.
ammóna a sapúlen	he knows how to look for it.
kayátda a gatáñgen	they want to buy it.

2. Present participle:

a. A verb connected with a predicate by the ligature *a* or *ñga*. *See* The Ligature *a* or *ñga* (II, B, 9).[8] Examples:

nadarásyo ñga inála	you were quick getting it.
nasadút a mamúnag	he is lazy in carrying.

b. An adjectival verb connected with another adjectival verb by the ligature *a* or *ñga*. *See* The Ligature *a* or *ñga* (II, B, 13).[9] Examples:

agpukpukkáwkayo a matmatúrog	you shout in your sleep (literally: sleeping).
agsursúrat a mañgmañgán	he writes eating.
agbasbásaka a magmagná	you read walking.
agináyadda ñga agtaráy	they run slowly (literally: they go slow running).

c. An adjectival verb connected with *addá* by the ligature *a* or *ñga*. *See* The Ligature *a* or *ñga* (II, B, 14).[10] Examples:

addá ñga umáy	there he is coming.
addáda a mayát	there they are willing.

d. A substantival verb connected with an adjectival verb by the ligature *a* or *ñga*. *See* The Ligature *a* or *ñga* (II, B, 12).[11] Examples:

di sumuñgbát ñga ayabán	he does not answer being called.
di tumaliáw a pakisaoán	he does not look back being spoken to.

NOTE 2. It goes without saying that the above division is more or less arbitrary, as the English forms and the Iloko forms are of an entirely different nature. That is the reason why we always refer to the corresponding treatment under the ligature.

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[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Ibid.

IX. The English past participle is rendered into Iloko:

1. By an adjectival verb in *na*. *See* The Prefix *Ma*.[12] Examples:

naarámid	it is done.
naipatakdér ti baláy	the house is built.
naipaw-ít ti súrat	the letter is sent.
naasinán ti kárne	the meat is salted.

2. By a substantival verb in the past. Examples:

tinadtád	hashed.
linága daytá	that is woven.
tinúno ti kayátmi	we want roasted (meat, and the like).
inan͠gér komá	it should be boiled (meat).
inpaksét	burnt (rice, and the like).
minuláan	planted.
rinan͠ggásan	injured.
agarámidka ití linúgaw	make rice porridge.
inkapilítan ti panagkonáda	they say so under compulsion (literally: they are obliged).
ginagára ti pannakaitibkúlna	he stumbles on purpose (literally: intentionally).
aláem ti inapúy	take rice (literally: placed over the fire).
binubódan ti inuménda	they drink rice wine (literally: fermented).
inkíwar ti intédda	they gave us pudding (literally: stirred).

AUXILIARIES

I. The most used auxiliaries are:

1. *In* and *mapán:* to go.

2. *Umáy:* to come.

II. The auxiliaries always precede the principal verb immediately without any connecting ligature. Examples:

in agbírok	he goes to look for some.
mapán man͠gála	he goes to take some.
umáy agtákaw	he comes to steal.

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[12] Philip. Journ. Sci. 71 (1940) 22.

III. All pronouns, adverbs, and so on, that have to be joined to the verb, are always joined to the auxiliary and never to the principal verb. Examples:

ínnak aláen	I go to take it.
ínkam biróken	we go to look for it.
ínnak agláko	I go to sell.
ínkam aglúto	we go to cook.
ínkanto ipúlan͠g	you will go and return it.
ínkaminsa matúrog	I think we better go to sleep.
mapántayo man͠gáyo	let us go to gather wood.
mapánda gumátan͠g	they go to buy.
mapántayo baúten	let us go and whip him.
mapánda sagádan	they go to sweep it.
mapánto man͠gán	he will go to eat.
umáyda suróten	they come to follow him.
umáykayo makiay-áyam	come and play with us.
umáyda makisaríta	they come to talk with us.
umáykayo saplíten	come and whip him.
umáysa uminúm	he probably comes to drink.
ti umáyna itatáo	his coming to become man.
kaanó ti immáyna panan͠gtéd ití daytóy	when did he bring this?

IV. When the principal verb is in the past tense the auxiliary has to be put in the same tense, provided that it be susceptible of a past form. The same rule applies to any verb connected with another verb in the past. Examples:

ínnak inála	I went to take it.
ínkam binírok	we went to look for it.
napántayo nan͠gáyo	we went to gather wood.
napánda gimmátan͠g	they went to buy.
napántayo bináut	we went to whip him.
napánda sinagádan	they went to sweep it.
immáyda sinúrot	they came to follow him.
immáykayo nakiay-áyam	you came to play with us.
immáyda nakisaríta	they came to talk with us.
immáykayo sinaplít	you came to whip him.
nagináyad a nagtaráy	he ran slowly.
nagbasbása a nagnagná	he read walking.
nagsursúrat a nan͠gnan͠gán	he wrote eating.
di simmun͠gbát n͠ga inayabán	he did not answer when called.
kinayátmi ti nagádal	we wanted to study.
intédna n͠ga inpainúm	he gave it to drink.
nabalínko komá n͠ga inláko	I could have sold it.
rinugiánda a kinoná	they began to say.

REDUPLICATION OF VERBAL STEMS

I. Besides the several reduplications alluded to in the above treatment of the verb, the Iloko use extensively two kinds of reduplication of verbal stems:

1. The reduplication of the first open syllable.
2. The reduplication of the first open syllable with the next consonant if there is any.

A third one, the reduplication of two syllables, is not so common.[13]

II. 1. The first of these reduplications indicates a certain easiness, cleverness, naturalness, and so on, in the performing of the action, and so it very often indicates that something is done by many. For example: *agtugáw:* he sits; *agtutugáw:* he sits in peace, easily, restfully; *tumugáw:* he sits down; *tumutugáw:* he sits down for the smallest reason, he cannot stand for any length of time; *kumagát:* he bites (although not actually); *kumakagát:* he is a fierce one always ready to bite; *agápada:* they quarrel; *agaápada:* they (more than two) quarrel. Examples:

agiináda	they are mother and daughters.
aguulitégda	they are uncle and nephews.
nagtutúlagda a duá	both made a contract.
agtatakdérkayo	stand up.
agguguranggúradanto	they will hate one another.
no panagaápit	at the time of the harvest.
agsasallópan͠gda	they face one another.
umaárem daytá baró	that young man is very much in love.
ti pagdudupudúpan	the meeting place.
lumulúto ti asáwak	my husband is a cook.
umaágas ni Pédro	Peter is a physician.
agaaráyatda	they lend a helping hand.
agsasagunsagúday dagitá	those try to outdo one another in good qualities.
nagdidígusda ámin	they all bathed.
ti panagaáyko ditóy	my coming here.
isú ti nagsasayaátanda	that is what makes them good.
ti pagoornón͠gan ti rugít	the place where dirt gathers.
dumadáit ni Ana	Ann is a seamstress.
sumusúrat daytá balásan͠g	that girl is a writer.
umaápalkayo	you are jealous.
ti pagsasan͠goán	where one faces others.

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[13] Notes on Iloko (Chapter I. VII. Reduplications, I). Anthropos 23 (1928) 1040.

NOTE 3. When the stem is a name of an animal, and the like, this reduplication and the prefix *ag* or *mañg* very often mean: to steal the animal, and so on, in question. Examples:

agkakaldíñg dagitá	those steal goats.
mañgkakaldíñgda	they steal goats.
mañgnunuáñg ti kailiám	your fellow citizen steals carabaos.
mamabábuy dagitóy a lakáy	these old men steal pigs.
agpapágay ti kaaróbami	our neighbor steals rice.
nagiitlóg daytá púsa	that cat stole eggs.
agbabayábas dagití ubbíñg	the boys steal guavas.

2. The second of these reduplications corresponds to our own progressive form. For example: *agtugáw:* he sits; *agtugtugáw:* he is sitting; *tumugáw:* he sits down; *tumugtugáw:* he is sitting down. Examples:

agtartaráy ni León	Leo is running.
nagbasbása idí malém	he was reading yesterday afternoon.
tumartaráy pay láeñg	he is still running.
immin-inúm ti áso	the dog was drinking.
makaturtúrog daytá ubíñg	that child is getting sleepy.
nakasarsárakda ití ugsá	they were meeting a deer.
makiriñgriñggór ken kabsátko	he is quarreling with my brother.
nakidawdáwat kaniák ití árak	he was asking me for wine.
mañgal-ála ití bagásmi	he is taking our rice.
nañgbakbakláy ití nadagsén	he was carrying a heavy load.
puspusáen ti tinápay	the bread is being eaten by the cat.
inas-áso ti kárne	the meat was being eaten by the dog.
makitkíta ti baláy	the house can be seen.
nabanbantáyan ti págay	the rice was being watched.
sursurótennakami	he is following us.
binirbírokmi idá	we were looking for them.
banbantáyanna ti bakét	he is watching the old woman.
sinagsagádanda ti silídko	they were sweeping my room.
ipulpúlañgda ti pagsiláwan	they are returning the lamp.
inbabbabáda ti págay	they were lowering the rice.
ibaybayoánna idá	he is pounding rice for them.
inar-aramídanda ni kabsátko ti baláy	they were making a house for my brother.
masapsápulko	I am needing it.
nasagságidko	I was touching him.

3. The third of these reduplications indicates repetition of the same action. For example: *agtaliáw:* he looks around; *agtaliataliáw:* he looks around all the time. Examples:

agsublisublí ti ubín͠g	the child is coming and going.
ti panagbaliwbáliw ti nákem	fickleness.
nagsardesardén͠gkami	we stopped repeatedly.
agwakatwákat ti pandilín͠gna	her shirt moves back and forth.
sumurotsúrot ti kaldín͠g	the goat follows all the time.
uman͠ges-án͠ges ta nagtaráy	he is panting for breadth because he ran.
masinasínada	they all separate.
naiwaraswáras ti lúpot	the clothes are scattered around.
kamatkamátenda idá	they persecute them.
pisan͠gpisán͠genna	he tears it up.
ginuyodgúyodda	they dragged him along.
inyunay-únayna	he recommended it insistingly.

III. When no consonant follows the first vowel of the stem:

1. The reduplication of the first open syllable retains its original meaning of easiness, and so on.

2. The progressive form is indicated by the reduplication of the initial open syllable and—

a. The shifting of the accent from the last of the two consecutive vowels of the stem, to the reduplicated syllable;

b. The reduplication of the initial consonant of the stem, if the first of the two consecutive vowels of the stem bears the accent, or if a suffix has drawn the accent after it.[14]

For example: *a. agsaó:* he talks; *agsasaó:* he talks much, noisily; *agsásao:* he is talking; *sumaó:* he speaks; *sumasaó:* he speaks well, fluently; *sumásao:* he is speaking. *b. agdáit:* she sews; *agdadáit:* she sews nicely; *agdaddáit:* she is sewing; *dumáit:* she can sew, she knows how; *dumadáit:* she sews well, she is a good seamstress, although she does not always sew; *dumaddáit:* she is sewing for a while; *saoénna:* he says; *sasaoénna:* he always says; *sassaoénna:* he is saying; *daítenna:* she sews it; *dadaítenna:* she sews it nicely, with ease; *dadduítenna:* she is sewing it.

IV. 1. When a syllable of the stem has been eliminated by syncope, through the addition of a prefix or infix, this prefix, for example, is considered, at least partially if it has more than one syllable, as a part of the stem, when reduplication occurs.[15] Examples:

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[14] Notes on Iloko Chapter I, IV. Accent, 2. Retrogression, III & IV; VII. Reduplications, 2.

lumlumtég ti luppóna	his thigh is swollen.
mañgmañgán ti ubíñg	the child is eating.
manmanbí ni Ana	Ann is spinning.
mabmabló ti sákak	my foot is sprained.
kalkalpás ti lúto	the cooking is just finished.
ipadpadláwna ti kinakúneñgna	he shows his stupidity.
nakaskasdáaw ti makíta	the sight is wonderful.
nakalkaldáañg a buybuyáen	it is a pitiful sight.
makañgkañgñgég	he can hear.

2. When the prefix is a complex one, very often the initial prefix alone is considered as such, and the rest is considered as a part of the stem, when reduplication occurs.[16] Examples:

agiinnokómda	they judge one another.
agtitinnúloñg dagití kaaróbami	our neighbors help one another.
agiinnápal dagití balásañg	the girls envy one another.
aglilinnípatda	they forget one another.
agpipinnaútañg dagití gayyémmi	our friends lend money to one another.
nagpipinnanúnotda ití biáñgda	they thought among themselves.
agkakasinsínda	they are first cousins.
agkakataráyda	they run all together.
díkayo agkakapagná	do not walk all together.
agparparikná	he is making insinuations.
agpaspasúrotda ñga agluálo	they are leading the prayers.
agkarkaraipugsát ti talí	the rope is breaking all the time.
pagtagtagiammoán daytá	that is doubtful.
agin-innonákam ñga agkabláaw	we vie to be the first to greet him.
mamagpagságad ti bakét	the old woman is ordering sweeping.
naikaskasígud ti ayátna	he has always loved.
maipappapílit	it has to be.

3. Sometimes either the whole complex prefix, or a simple prefix, at least partially if it has more than one syllable, may

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[15] Notes on Iloko. Chapters I, VI. Syncopations, etc. I. Note. Anthropos 23 (1928) 1035.

[16] Notes on Iloko. Chapters I, VII. Reduplications, I. Note 1. Anthropos 23 (1928) 1040.

be considered a part of the stem, when reduplication occurs.[17] Examples:

um-umáy ti áso	the dog is coming.
rimrimmuár ti púsa	the cat was coming out.
mañgmañgtédkayo	you are giving.
ik-ikkám idá	give them.
marmaruám daytá	that one is getting used to it.
padpadaksénda ti gayyémda	they are slandering their friend.
pinalpalubósanna ti anákna	he was letting his son go.
pappapudótem	warm it.
parparagsákem ti inám	make your mother happy.
ipappapánko a kastá	I am supposing so.
makimkimísakami	we are always going to mass.
isú ti nakabkabasólanna	that is where he made a mistake.
natnatúrog dagití ubbíñg	the children were sleeping.
nañgnañgróna a dákes	it is especially bad.
sañgsañgkagiddánda ñga aramíden	they do it all together
mamasírib dagitá lakáy	those old men are wise.

NOTE 4. The prefix *i* of complex prefixes is never considered as a part of the stem, provided it follows the simple prefix immediately. Examples:

agipabpabásol ti kaádalko	my classmate is accusing people.
agitartaráy kadagití kúkuami	he is running away with our property.
mañgmañgyég ití bagás	he is bringing rice.
But: *agkarkaraibóoñg*	he always breaks things.

SYNOPSIS

To give an idea of the great number of forms a verbal stem may acquire through the addition of verbal prefixes, infixes, and suffixes, and through the different reduplications, we shall give here a list of the verbal forms of the stem *súrat,* 'writing.' This list, however, is far from complete, and we hope the student will be kind enough to supply any omissions, which might readily occur in such an enumeration.

This list is an obvious vindication of the linguist who arranges a dictionary of Iloko according to stems, and not according to complete words. It should be noted, however, that several of these forms are rarely used, and that some of them are not allowed with all verbal stems. One may have lived for years in the Iloko country without having heard each and every one of these forms; nevertheless, they are all correct and may be used occasionally, some more, others less.

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[17] Notes on Iloko. Chapters I, VII. Reduplications, I. Notes 1 & 2. Anthropos 23 (1928) 1040, 1041.

1. PREFIX *AG*

PRESENT	ENGLISH PRESENT	PAST
agsúrat	he writes	*nagsúrat*
agsusúrat	he writes well	*nagsusúrat*
agsursúrat	he is writing	*nagsursúrat*

NOTE 5. As it would be tedious to repeat this triple form with each separate item of this table, we shall only give the forms without reduplications; it should be noted, however, that this triple form is always allowed, except when the first open syllable is reduplicated in the original form, for example, *aginsusúrat, isusúrat,* and so on, in which case only the original form is allowed. Sometimes a part of the complex prefix is considered a part of the stem, and affects reduplications accordingly; for example: the reduplications of the form *agpasúrat* are: *agpapasúrat* and *agpaspasúrat.*

PRESENT	ENGLISH PRESENT	PAST
managsúrat	he writes much	
pagsúrat	something to write with	*pinagsúrat*
pagsurátan	where, why, to whom one writes	*nagsurátan*
panagsúrat	how, when one writes	
panagsurátan	writing	
pagsuráten	to order somebody to write	*pinagsúrat*
mañgpagsúrat	he orders somebody to write	*nañgpagsúrat*
mamagsúrat	do.	*namagsúrat*
manañgpagsúrat	he often orders somebody to write	
manamagsúrat	do.	
mammagsúrat	do.	
pañgpagsúrat	something with which to order somebody to write	*pinañgpagsúrat*
pamagsúrat	do.	*pinamagsúrat*
pañgpagsurátan	where, why, to whom one orders somebody to write	*nañgpagsurátan*
pamagsurátan	do.	*namagsurátan*
panañgpagsúrat	how, when one orders somebody to write.	
panamagsúrat	do.	
pammagsúrat	do.	
panañgpagsurátan	ordering somebody to write	
panamagsurátan	do.	
pammagsurátan	do.	
pañgpagsuráten	to order somebody to order another one to write	*pinamagsúrat*
pamagsuráten	do.	*pinañgpagsúrat*
mapagsúrat	he is ordered to write	*napagsúrat*

NOTE 6. The student will kindly supply each of the next forms, in which the complex prefixes are derived from the simple prefix *ag*, with all the above forms, 38 in number.

agsanúrat	he always writes	*nagsanúrat*
agisúrat	he writes something down	*nagisúrat*
agpasúrat	he orders somebody to write	*nagpasúrat*
agpanúrat	do.	*nagpanúrat*
agpaisúrat	he orders somebody to write something down	*nagpaisúrat*
agipasúrat	he gives something to be written	*nagipasúrat*
agpaipasúrat	he orders somebody to give something to be written	*nagpaipasúrat*
aginsusúrat	he pretends to write	*naginsusúrat*
agpaginsusúrat	he orders somebody to pretend to write	*nagpaginsusúrat*
agsinnúrat	to write to one another	*nagsinnúrat*
agpasinnúrat	to order to write to one another	*nagpasinnúrat*
agpinnasúrat	to order one another to write	*nagpinnasúrat*
agpinnaisúrat	to order one another to write something down	*nagpinnaisúrat*
agpinnaipasúrat	to order one another to give something to be written	*nagpinnaipasúrat*
agsuransúrat	to write to one another	*nagsuransúrat*
agpasuransúrat	to order to write to one another	*nagpasuransúrat*
agsinnuransúrat	to write to one another	*nagsinnuransúrat*
agpasinnuransúrat	to order to write to one another	*nagpasinnuransúrat*
agkaraisúrat	he always writes something down	*nagkaraisúrat*
agkaraipasúrat	he always orders somebody to write	*nagkaraipasúrat*
agkaraipaisúrat	he always orders somebody to write something down	*nagkaraipaisúrat*
agkaraipaipasúrat	he always orders somebody to give something to be written	*nagkaraipaipasúrat*
agtagisúrat	he has a letter	*nagtagisúrat*
agtagipagsúrat	he has something to write with	*nagtagipagsúrat*

agtagipagisúrat	he has something with which to write something down	*nagtagipagisúrat*
agtagipagipasúrat	he has something to give something to be written	*nagtagipagipasúrat*
agtagipagpasúrat	he has something to order somebody to write	*nagtagipagpasúrat*
agtagipagpaisúrat	he has something to order somebody to write something down	*nagtagipagpaisurat*
agtagipagpaipasúrat	he has something to order somebody to give something to be written	*nagtagipagpaipasúrat*
etc.	etc.	etc.

2. INFIX *UM*

sumúrat	he writes for a while	*simmúrat*
isusúrat	how, when one writes for a while	
pasuráten	to tell somebody to write	*pinasúrat*
man͠gpasúrat	he tells somebody to write	*nan͠gpasúrat*
mamasúrat	do.	*namasúrat*
manan͠gpasúrat	he often tells somebody to write	
manamasúrat	do.	
mammasúrat	do.	
pan͠gpasúrat	something with which to tell somebody to write	*pinan͠gpasúrat*
pamasúrat	do.	*pinamasúrat*
pan͠gpasurátan	where, why, to whom one tells somebody to write	*nan͠gpasurátan*
pamasurátan	do.	
panan͠gpasúrat	how, when one tells somebody to write	*namasurátan*
panamasúrat	do.	
pammasúrat	do.	
panan͠gpasurátan	telling somebody to write	
panamasurátan	do.	
pammasurátan	do.	

pañgpasuráten	to order somebody to tell another one to write	*pinañgpasúrat*
pamasuráten	do.	*pinamasúrat*
mapasúrat	he is told to write	*napasúrat*
etc.	etc.	etc.

3. PREFIX *MAKA*

makasúrat	he can write	*nakasúrat*
mannakasúrat	he can write much	
pakasurátan	where, why, to whom one can write	*nakasurátan*
pannakasúrat	how, when one can write	
pannakasurátan	being able to write	
pakasuráten	to make somebody able to write	*pinakasúrat*
mañgpakasúrat	he makes somebody able to write	*nañgpakasúrat*
mamakasúrat	do.	*namakasúrat*
manañgpakasúrat	he often makes somebody able to write	
manamakasúrat	do.	
mammakasúrat	do.	
pañgpakasúrat	something with which to make somebody able to write	*pinañgpakasúrat*
pamakasúrat	do.	*pinamakasúrat*
pañgpakasurátan	where, why, to whom one makes somebody able to write	*nañgpakasurátan*
pamakasurátan	do.	*namakasurátan*
panañgpakasúrat	how, when one makes somebody able to write	
panamakasúrat	do.	
pammakasúrat	do.	
panañgpakasurátan	making somebody able to write	
panamakasurátan	do.	
pammakasurátan	do.	
pañgpakasuráten	to order somebody to make another able to write	*pinañgpakasúrat*
pamakasuráten	do.	*pinamakasúrat*
mapakasúrat	he is made able to write	*napakasúrat*

NOTE 7. The student will kindly supply each of the next forms, in which the complex prefixes are derived from the simple prefix *maka*, with all the above forms, 36 in number.

makaisúrat	he can write something down	*nakaisúrat*
makapagsúrat	it is possible for him to write	*nakapagsúrat*
makapagisúrat	it is possible for him to write something down	*nakapagisurat*
makapagsinnúrat	to be able to write to one another	*nakapagsinnúrat*
makapagsuransúrat	do.	*nakapagsuransúrat*
makapagsinnuransúrat	do.	*nakapagsinnuransúrat*
makapagpasúrat	it is possible for him to have something written	*nakapagpasúrat*
makapagpaisúrat	it is possible for him to have something written down	*nakapagpaisúrat*
makapagpaipasúrat	it is possible for him to give something to be written	*nakapagpaipasúrat*
makapagtagisúrat	it is possible for him to have a letter	*nakapagtagisúrat*
makapagtagipagsúrat	it is possible for him to have something to write with	*nakapagtagipagsúrat*
makapagtagipagisúrat	it is possible for him to have something with which to write something down	*nakapagtagipagisúrat*
makapagtagipagipasúrat	it is possible for him to have something to give something to be written	*nakapagtagipagipasúrat*
makapagtagipagpasúrat	it is possible for him to have something to order somebody to write	*nakapagtagipagpasúrat*
makapagtagipagpaisúrat	it is possible for him to have something to order somebody to write something down	*nakapagtagipagpaisúrat*
makapagtagipagpaipasúrat	it is possible for him to have something to order somebody to give something to be written	*nakapagtagipagpaipasúrat*

makapaginsusúrat	it is possible for him to pretend to write	*nakapaginsusúrat*
makapasúrat	he can have something written	*nakapasúrat*
makapanúrat	he can order somebody to write	*nakapanúrat*
makapaisúrat	he can have something written down	*nakapaisúrat*
makapaipasúrat	he can give something to be written	*nakapaipasúrat*
etc.	etc.	etc.

4. PREFIX MAKI

makisúrat	he writes with others	*nakisúrat*
mannakisúrat	he writes much with others	
pakisúrat	something with which to write with others	*pinakisúrat*
pakisurátan	where, why, to whom one writes with others	*nakisurátan*
pannakisúrat	how, when one writes with others	
pannakisurátan	writing with others	
pakisuráten	to order somebody to write with others	*pinakisúrat*
mañgpakisúrat	he orders somebody to write with others	*nañgpakisúrat*
mamakisúrat	do.	*namakisúrat*
manañgpakisúrat	he often orders somebody to write with others	
manamakisúrat	do.	
mammakisúrat	do.	
pañgpakisúrat	something with which to order somebody to write with others	*pinañgpakisúrat*
pamakisúrat	do.	*pinamakisúrat*
pañgpakisurátan	where, why, to whom one orders somebody to write with others	*nañgpakisurátan*
pamakisurátan	do.	*namakisurátan*
panañgpakisúrat	how, when one orders somebody to write with others	
panamakisúrat	do.	
pammakisúrat	do.	
panañgpakisurátan	ordering somebody to write with others	
panamakisurátan	do.	
pammakisurátan	do.	

pan̄gpakisuráten	to order somebody to order another to write with others	*pinan̄gpakisúrat*
pamakisuráten	do.	*pinamakisúrat*
mapakisúrat	he is ordered to write with others	*napakisúrat*

NOTE 8. The student will kindly supply each of the next forms, in which the complex prefixes are derived from the simple prefix *maki*, with all the above forms, 38 in number.

makisinnúrat	to write to one another	*nakisinnúrat*
makisuransúrat	do.	*nakisuransúrat*
makisinnuransúrat	do.	*nakisinnuransúrat*
makisumúrat	he wants to write	*nakisumúrat*
makipagsúrat	he also writes with others	*nakipagsúrat*
makipagisúrat	he also writes something down with others	*nakipagisúrat*
makipaginsusúrat	he pretends with others to be writing	*nakipaginsusúrat*
makipagsinnúrat	also to write to one another	*nakipagsinnúrat*
makipagsuransúrat	also to write with others	*nakipagsuransúrat*
makipagsinnuransúrat	do.	*nakipagsinnuransúrat*
makipagpasúrat	he also with others orders something to be written	*nakipagpasúrat*
makipagpaisúrat	he also with others orders something to be written down	*nakipagpaisúrat*
makipagpaipasúrat	he also with others gives something to be written	*nakipagpaipasúrat*
makipasúrat	he also orders something to be written	*nakipasúrat*
makipanúrat	he also orders somebody to write	*nakipanúrat*
makipaisúrat	he also orders something to be written down	*nakipaisúrat*
makipaipasúrat	he also gives something to be written	*nakipaipasúrat*
etc.	etc.	etc.

5. SUFFIX *EN*

suráten	to write something	*sinúrat*
mañgsúrat	he writes something	*nañgsúrat*
manúrat	do.	*nanúrat*
manañgsúrat	he writes many things	
mananúrat	do.	
mannúrat	do.	
pañgsúrat	something to write something with	*pinañgsúrat*
panúrat	do.	*pinanúrat*
pañgsurátan	where, why, to whom one writes something	*nañgsuratan*
panurátan	do.	*nanurátan*
panañgsúrat	how, when one writes something	
pananúrat	do.	
pannúrat	do.	
panañgsurátan	writing something	
pananurátan	do.	
pannurátan	do.	
pañgsuráten	to order somebody to write something	*pinañgsúrat*
panuráten	do.	*pinanúrat*
mañgpañgsúrat	he orders somebody to write something	*nañgpañgsúrat*
mañgpanúrat	do.	*nañgpanúrat*
mamañgsúrat	do.	*namañgsúrat*
mamanúrat	do.	*namanúrat*
manañgpañgsúrat	he often orders somebody to write something	
manañgpanúrat	do.	
manamañgsúrat	do.	
manamanúrat	do.	
mamañgsúrat	do.	
mammanúrat	do.	
pañgpañgsúrat	something with which to order somebody to write something	*pinañgpañgsúrat*
pañgpanúrat	do.	*pinañgpanúrat*
pamañgsúrat	do.	*pinamañgsúrat*
pamanúrat	do.	*pinamanúrat*
pañgpañgsurátan	where, why, to whom one orders somebody to write something	*nañgpañgsurátan*
pañgpanurátan	do.	*nañgpanurátan*
pamañgsurátan	do.	*namañgsurátan*
pamanurátan	do.	*namanurátan*

panan͠gpan͠gsúrat	how, when one orders somebody to write something	
panaman͠gsúrat	do.	
panamanúrat	do.	
pamman͠gsúrat	do.	
pammanúrat	do.	
panan͠gpan͠gsurátan	ordering somebody to write something	
panan͠gpanurátan	do.	
panaman͠gsurátan	do.	
panamanurátan	do.	
pamman͠gsurátan	do.	
pammanurátan	do.	
pan͠gpan͠gsuráten	to order somebody to order another to write something	*pinan͠gpan͠gsúrat*
pan͠gpanuráten	do.	*pinan͠gpanúrat*
paman͠gsuráten	do.	*pinaman͠gsúrat*
pamanuráten	do.	*pinamanúrat*
mapan͠gsúrat	do.	*napan͠gsúrat*
mapanúrat	he is ordered to write something	*napanúrat*
masúrat	do.	*nasúrat*
pasúrat	it is written	*pinasúrat*
man͠gpasúrat	to order something to be written	*nan͠gpasúrat*
mamasúrat	he orders something to be written	*mamasúrat*
manan͠gpasúrat	he often orders something to be written	
manamasúrat	do.	
mammasúrat	do.	
pan͠gpasúrat	something with which to order something to be written	*pinan͠gpasúrat*
pamasúrat	do.	*pinamasúrat*
pan͠gpasurátan	where, why, to whom one orders something to be written	*nan͠gpasurátan*
pamasurátan	do.	*namasurátan*
panan͠gpasúrat	how, when one orders something to be written	
panamasúrat	do.	
pammasúrat	do.	
panan͠gpasurátan	ordering something to be written	
panamasurátan	do.	
pammasurátan	do.	

pañgpasuráten	to order somebody to order something to be written	*pinañgpasúrat*
pamasúraten	do.	*pinamasúrat*
mapasúrat	it is ordered to be written	*napasúrat*
etc.	etc.	etc.

6. SUFFIX *AN*

surátan	to write on something	*sinurátan*
masurátan	it is written upon	*nasurátan*
pasurátan	to order something to be written upon	*pinasurátan*
mapasurátan	it is ordered to be written upon	*napasurátan*
etc.	etc.	etc.

7. PREFIX *I*

isúrat	to write something down	*insúrat*
mañgisúrat	he writes something down	*nañgisúrat*
manañgisúrat	he writes many things down	
pañgisúrat	something to write something down	*pinañgisúrat*
pañgisurátan	where, why, to whom one writes something down	*nañgisurátan*
panañgisúrat	how, when one writes something down	
panañgisurátan	writing something down	
pañgisuráten	to order somebody to write something down	*pinañgisúrat*
mañgpañgisúrat	he orders somebody to write something down	*nañgpañgisúrat*
mamañgisúrat	do.	*namañgisúrat*
manañgpañgisúrat	he often orders somebody to write something down	
manamañgisúrat	do.	
mammañgisúrat	do.	
pañgpañgisúrat	something with which to order somebody to write something down	*pinañgpañgisúrat*
pamañgisúrat	do.	*pinamañgisúrat*

pañgpañgisurátan	where, why, to whom to order somebody to write something down	*nañgpañgisurátan*
pamañgisurátan	do.	*namañgisurátan*
panañgpañgisúrat	how, when to order to write something down	
panamañgisúrat	do.	
pammañgisúrat	do.	
panañgpañgisurátan	ordering somebody to write something down	
panamañgisurátan	do.	
pammañgisurátan	do.	
pañgpañgisuráten	to order somebody to order another to write something down	*pinañgpañgisúrat*
pamañgisuráten	do.	*pinamañgisúrat*
mapañgisúrat	he is ordered to write something down	*napañgisúrat*
maisúrat	it is written down	*naisúrat*
paisúrat	to order something to be written down	*pinaisúrat*
mañgpaisúrat	he orders something to be written down	*nañgpaisúrat*
mamaisúrat	do.	*namaisúrat*
manañgpaisúrat	he orders many things to be written down	
manamaisúrat	do.	
mammaisúrat	do.	
pañgpaisúrat	something with which to order something to be written down	*pinañgpaisúrat*
pamaisúrat	do.	*pinamaisúrat*
pañgpaisurátan	where, why, to whom one orders something to be written down	*nañgpaisurátan*
pamaisurátan	do.	*namaisurátan*
panañgpaisúrat	how, when one orders something to be written down	
panamaisúrat	do.	
pammaisúrat	do.	
panañgpaisurátan	ordering something to be written down	
panamaisurátan	do.	
pammaisurátan	do.	

pañgpaisuráten	to order somebody to order something to be written down	*pinañgpaisúrat*
pamaisuráten	to order somebody to order something to be written down	*pinamaisúrat*
mapaisúrat	it is ordered to be written down	*napaisúrat*
etc.	etc.	etc.

8. COMBINATION *I . . . AN*

isurátan	to write something for somebody	*insurátan*
maisurátan	something is written for him	*naisurátan*
paisurátan	to order something to be written for somebody	*pinaisurátan*
mapaisurátan	something is ordered to be written for him	*napaisurátan*
etc.	etc.	etc.

9. PREFIX *IPA*

ipasúrat	to give something to be written	*inpasúrat*
mañgipasúrat	he gives something to be written	*nañgipasúrat*
manañgipasúrat	he gives many things to be written	
pañgipasúrat	something with which to give something to be written	*pinañgipasúrat*
pañgipasurátan	where, why, to whom one gives something to be written	*nañgipasurátan*
panañgipasúrat	how, when one gives something to be written	
panañgipasurátan	giving something to be written	
pañgipasuráten	to order somebody to give something to be written	*pinañgipasúrat*
mañgpañgipasúrat	he orders somebody to give something to be written	*nañgpañgipasúrat*
mamañgipasúrat	do.	*namañgipasúrat*
manañgpañgipasúrat	he often orders somebody to give something to be written	
manamañgipasúrat	do.	
mammañgipasúrat	do.	

pañgpañgipasúrat	something to order somebody to give something to be written	*pinañgpañgipasúrat*
pamañgipasúrat	do.	*pinamañgipasúrat*
pañgpañgipasurátan	where, why, to whom one orders somebody to give something to be written	*nañgpañgipasurátan*
pamañgipasurátan	do.	*namañgipasurátan*
panañgpañgipasúrat	how, when one orders somebody to give something to be written	
panamañgipasúrat	do.	
pammañgipasúrat	do.	
panañgpañgipasurátan	ordering somebody to give something to be written	
panamañgipasurátan	do.	
pammañgipasurátan	do.	
pañgpañgipasuráten	to order somebody to order another to give something to be written	*pinañgpañgipasúrat*
pamañgipasuráten	do.	*pinamañgipasúrat*
mapañgipasúrat	he is ordered to give something to be written	*napañgipasúrat*
maipasúrat	it is given to be written	*naipasúrat*
paipasúrat	to order something to be written	*pinaipasúrat*
mañgpaipasúrat	he orders something to be given to be written	*nañgpaipasúrat*
mamaipasúrat	do.	*namaipasúrat*
manañgpaipasúrat	he often orders something to be given to be written	
manamaipasúrat	do.	
mammaipasúrat	do.	
pañgpaipasúrat	something with which to order something to be given to be written	*pinañgpaipasúrat*
pamaipasúrat	do.	*pinamaipasúrat*
pañgpaipasurátan	where, why, to whom one orders something to be given to be written	*nañgpaipasurátan*
pamaipasurátan	do.	*namaipasurátan*

panan̄gpaipasúrat	how, when one orders something to be given to be written	
panamaipasúrat	do.	
pammaipasúrat	do.	
panan̄gpaipasurátan	ordering something to be given to be written	
panamaipasurátan	do.	
pammaipasurátan	do.	
pan̄gpaipasuráten	to order somebody to order something to be given to be written	*pinan̄gpaipasúrat*
pamaipasuráten	do.	*pinamaipasúrat*
mapaipasúrat	it is ordered to be given to be written	*napaipasúrat*
etc.	etc.	etc.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Dictionary of Geological Terms (exclusive of stratigraphic formations and paleontologic genera and species). By C. M. Rice. Ann Arbor, Michigan, Edwards Brothers, Inc., 1940. 461 pp. Price, $6.

This dictionary is a very complete compilation of geological terminology and contains about 15,000 terms. Each term is followed by a brief definition which has been extracted from a previous compilation on the word of a recognized authority, or which has been "edited and approved by that member of the Princeton Department of Geology in whose field the term lies." Reference to the former compilation or the authority quoted is given in parenthesis following the definition. The lack of reference to either the original definition or a recognized authority is a disadvantage to a reader desiring a more complete discussion. In some cases there seems to be an unnecessary disregard of controversial meanings.

In spite of these deficiencies, however, the book will be a worthwhile addition to the library of a geologist or a mining engineer as well as to a scientific library, for it is convenient to use and gives definitions of geological terms in a readily understandable form.—R. W. M.

Periodic Health Examination; a Manual for Physicians. 2d rev. ed. By the American Medical Association. Chicago, The Association, 1940. 104 pp., illus. Price, $0.25.

This pamphlet is a useful guide to the preservation of health and the amelioration of disease; namely, by the periodic medical examination of healthy or apparently healthy people, including prenatal as well as postnatal examination at all ages. Formerly the physician's attention was largely confined to examination of the sick and the application of appropriate remedies; now it is no less important task of forestalling sickness and suffering by examination of those who are well and advice against unhealthy habits and unhygienic modes of living. People should be advised that a periodic overhauling of the human machine is necessary for the preservation of health.—W. V.

Cancer, a Handbook for Physicians. Prepared by the Tumor Committee of the Connecticut State Medical Society. Hartford, The Connecticut State Department of Health, 1939. 193 pp., illus.

This little book is a handy reference for every physician. Although some books discuss cancer in a more detailed fashion, it is worthwhile for a practitioner to be able to get hold of one like this—concise yet informative. The State Tumor Committee of Connnecticut has done a great service in publishing this book. —P. S. C.

Social and Biological Aspects of Mental Diseases. By Benjamin Malzberg. Utica, New York, State Hospitals Press, 1940. 360 pp. Price, $2.50.

Numerous years of experience make Benjamin Malzberg, Ph. D., a capable researcher in the field of mental diseases. The present book is the result of the author's unprecedented and untiring effort in ransacking the noted libraries of psychiatric and mental clinics. It is well written and contains numerous tabulations. It will serve as a guide for students in the field of psychiatry. With its statistical tabulations it should facilitate a comparative and comprehensive study of the mental diseases as described in each chapter.—F. S. S. M.

Profitable Poultry Keeping. By H. Clyde Knandel. New York, Orange Judd Publishing Company, Inc., 1940. 462 pp., illus. Price, $3.

"Profitable Poultry Keeping," written by H. Clyde Knandel, Professor and Head of the Poultry Department of the Pennsylvania State College, is a fundamentally sound and practical text for beginners, vocational school pupils, college students in need of an elementary text in poultry husbandry, and farmers and commercial poultry raisers with practical poultry-keeping problems. The book was written to meet actual needs and to render the greatest possible service to all who are contemplating a study of poultry husbandry.

The style of the book offers four clear-cut educational advantages. At the beginning of each chapter several keynote questions are presented for the purpose of emphasizing the major objectives covered by the chapter. Each chapter is followed by discussion topics, laboratory projects, and further reading references which serve as teaching aids to the instructor and learning aids to the pupil and the general reader. Numerous topics and projects are offered, so that the teacher may choose those that best meet local conditions. Carefully selected references, for those who desire more information on any specific topic, are appended to each chapter. In addition, many helpful sources of other information, including a complete list of the standard classes, breeds, and varieties of poultry and the average percentage of commonly used poultry feeds, are given in the appendix. The book as a whole attempts to bring together in a brief and systematic fashion present-day knowledge of the problems encountered in poultry husbandry.

The author starts with a discussion, in Chapter I, of the importance, development, and exceptional vocational opportunities that poultry keeping offers. Step by step the science and art of poultry keeping are discussed, from the egg and its incubation in Chapter III, to the marketing and disposal of the final product.

In poultry, as well as in all branches of productive agriculture, better strains and breeds are now produced. This improvement is attributed to two major factors (1) environment and (2) improved breeding methods. The former includes feeds and feeding management, which are discussed in chapters V, VI, VII, and VIII, and housing, discussed in chapters IX, X, and XI. Problems and methods in poultry breeding including the fundamental laws involved are discussed in chapters XIII and XIV.

The biggest problem facing the poultry industry today is the high annual mortality caused by diseases and parasites. The failure of a poultry farm is almost invariably due to the ravages of disease and parasites of some kind. Chapter XVI deals with the common diseases and parasites, and includes a plan for disease prevention.

The author closes his book with a discussion on the different factors that may affect the poultryman's profit. As in any other business, personal attention plays a very important rôle in the successful operation of a poultry farm.

The text is well illustrated throughout with photographs of high instructional value, carefully chosen diagrams, charts, and tables.—R. G. M.

The Milking Goat; a Practical Hand-Book for the Novice, as well as a Book of Reference for the Seasoned Goat Dairyman. By M. R. Steffen. Vincennes, Indiana, W. L. Tewalt, 1940. 69 pp. Price, $1.

This little book, besides being easy to understand by the laity, contains worthwhile and practical information on the goat as a milk producer. At the beginning, however, the author is a little too anxious to give views that require proof. He mentions "an unknown factor in milk wholly divorced of our understanding of nutrition, etc., states that cow's milk is "rather crudely emulsified," and that "milk not fit to drink raw is not fit to drink at all." Canned and powdered milk are certainly wholesome and the most convenient form where fresh milk is not available. While this work is intended to give helpful hints to beginners, it is, nevertheless, a handy and useful reference for every farmer and every seasoned dairyman.—C. X. B.

Basket Pioneering: a Popular Hand-Book Containing Concise Basketry Directions with Clear Simple Diagrams—Designed for the Beginner as Well as the More Experienced Basket Weaver. By Osma Palmer Couch. Rev. ed. New York, Orange Judd Publishing Company, Inc., 1940. 163 pp., illus. Price, $1.75.

The book gives, in lesson form, various methods for making different kinds of baskets. Each lesson states the materials to be used, and the steps in making a basket, part by part, or in manipulating every kind of special material that is to be used.

That the processes involved in shaping the material are easy is evidenced by the fact that the materials are round, like vines, willow rods, and reeds, which require only a very few hand tools—the bolo or knife being the most important. Because of the abundance of materials for basket making in our forests, the art herein described should give rise to household industries and thus contribute much towards providing a means of livelihood to many who live near forests. The book is highly recommended as an addition to every school library, especially to every industrial school library.—C. P.

Money Making Formulas. Edited by C. A. Crowley. Chicago, Illinois, Popular Mechanics Press, 1939. 480 pp. Price, $4.35.

The title of this book is indeed attractive, and unlike similar publications, the book is more than a mere collection of formulas. It opens with a discussion of developing and marketing a new product. It tells how to use formulas, test them, and make improvements upon them. It also explains in a simple manner the various experimental methods, such as weighing, measuring, volume, grinding, mixing, making solutions, heating, filtration, distillation, compounding, and how to make emulsions, which are ordinarily encountered in an experimenter's laboratory. The main body of the book follows. It consists of twenty-five chapters devoted to discussions, methods of manufacture, and formulas of various kinds of commercial products, such as soaps, polishes, glues, paints, varnishes, cosmetics, food products, and pharmaceutical products. Each of these chapters is preceded by a very simple, nontechnical discussion of the characteristics and requisites of a particular class of products, like polishes, for example. The functions of the principal ingredients used in a certain formula and the methods of treating them to bring about the desired results are also discussed in some detail. References to more detailed or additional manufacturing information are found at the end of each chapter.

If one of the aims of this book is to acquaint "young chemists who, after leaving the university, are faced with the problem of finding out precisely what a chemist does to earn his pay," this aim is achieved in a large measure. To the experienced chemist entering a new industry this book will also be of great interest.—I. P.

Be Your Own Gardener. How to Make, Maintain and Find Satisfaction in Intimate Flower Gardens. By Sterling Patterson. New York and London, Harper & Brothers, 1940. 370 pp., illus. Price, $2.50.

This book, with its beautiful photographic illustrations and a glossary of garden terms, is intended primarily as a "guide, philosopher and friend" to hundred of thousands of Americans who cherish the art of garden making on a small scale. The author presents his subject matter in the simplest manner possible, based mostly on the application of tested principles and on his personal experience as to the fashioning and maintenance of flower gardens. The arts of designing a garden, fertilizing the soil, caring for lawns, and treating different garden species as to their requirements and arrangements, are given extensively. Although this book was written primarily to suit American conditions and tastes, many of the principles discussed can be applied in the Tropics, where many of the species mentioned can be satisfactorily grown and many naturalized ones can be substituted with the least trouble. Thus this book not only provides wholesome reading matter for garden-minded individuals to broaden their horizon in the art of gardening, but also serves as a guide to them in starting their own gardens.—J. B. J.

RECEIVED

American goat society, inc. 1940 yearbook. Lincoln, Nebraska, The Society, 1940. 237 pp., illus. Price, $1.

Branco Ribeiro, Eurico. Estudos Cirurgicos 3a. serie. São Paulo, Sociedade editora medica limitada, 1940. 219 pp., illus.

BRANCO RIBEIRO, EURICO. Pesquiza da alca jejunal em cirurgia gastrica. São Paulo, Sociedade editora medica limitada, 1940. 59 pp., illus.

The breeding of herbage plants in Scandinavia and Finland. Published by the Imperial bureau of plant breeding and genetics, school of agriculture, Cambridge, March, 1940. 124 pp., illus., tables. Price, 4 s/–.

CHEVEY, P., and F. LE POULAIN. La pêche dans les eaux douces du Cambodie . . . Saigon, Gouvernement général de L'Indochine, 1940. In 2 parts.

Colwell's daily log for physicians, 1941. A brief, simple accurate financial record for the physician's desk. Champaign, Illinois, Colwell publishing co. Unpaged.

DOUGLAS, J. H., and R. H. ROBERTS. Modern projects in woodwork. Wichita, Kansas, The McCormick-Mathers publishing co., 1939. 128 pp., illus., plates. Price, $2.25.

HESSEL, F. A., and others. Chemistry in warfare, its strategic importance. With a foreword by Crosby Field . . . and a technical appendix. New York, Hastings house, 1940. 164 pp., illus. Price, $2.

LEACH, CORL A. Aids to goatkeeping. 3d ed. Fairbury, Nebraska, Dairy goat journal, 1940. 104 pp., illus. Price, $1.

LEACH, CORL A. Principles of dairy goat selection. Fairbury, Nebraska, Dairy goat journal, 1940. 56 pp., illus., plates. Price, $1.

LORD, RUSSELL. The agrarian revival. A study of agricultural extension. New York, American association for adult education, 1939. 236 pp. Price, $1.50.

Mallory Yaxley approved precision products. 1940 catalog . . . Indianapolis, P. R. Mallory & co., inc., 1940. Unpaged.

Mallory Yaxley radio service encyclopedia. Compiled and published by P. R. Mallory & co., inc., 1939. 264 pp., illus., tables. Price, $1.25.

Reports of the Biochemical Research Foundation of the Franklin Institute, vol. V, 1938–1939. Philadelphia. 838 pp., illus., plates.

SMALLEY, H. R., and others. American fertilizer practices (second survey). A report relating to the use of commercial plant food presenting information obtained by a survey among 32,000 farmers in 35 states. Washington, D. C., National Fertilizer Association, 1939. 128 pp., illus., tables. Price, $1.

VANDERWALKER, F. N. The mixing of colors and paints. Chicago, Frederick J. Drake & co., 1939. 292 pp., illus. Price, $2.

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REDUCING THE ACIDITY OF MANILA COPAL

REACTION OF RUN COPAL AND GLYCEROL

By GLORIA D. MANALO and AUGUSTUS P. WEST
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ONE TEXT FIGURE

Natural resins are obtained as exudations of forest trees. They have been used for years in making high-grade varnishes. The copals are the most important of the natural resins. There are two general classes of copals, Congo and Manila. The Congo variety is obtained from the Congo district in Africa, while the Manila product comes from the Netherlands East Indies, the Malay States, and the Philippines.

In preceding reports [1] from this laboratory methods were given for analyzing and refining Manila copal, which was found to consist mostly of resin acids together with some terpenes, resenes, and material insoluble in alcohol. The insoluble matter is usually composed of gelatinous material together with foreign impurities. Oxidation of the copal apparently precedes the formation of the gel.

Soft Manila copal dissolves readily in alcohol, with the exception of the foreign matter and gelatinous material that may be contained in it. It is not soluble in drying oils, such as linseed oil. In order to make oil varnishes with this resin it is customary to heat it until the water, terpenes, and volatile decomposition products have been removed. This heating process is known in the varnish industry as running.

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[1] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259, 285; Manalo, G. D., and A. P. West, Philip. Journ. Sci. 74 (1941) 157.

Several investigations[2] have indicated that some of the acids in Manila copal are dibasic. When the resin is run (heated) at a temperature of about 300° to 310°C. to remove volatile constituents, the dibasic acids are converted to monobasic, thus reducing the acidity of the copal.

Samples of run Manila copal were recently prepared in this laboratory and a method[3] was devised for analyzing them. The composition of the copal was then determined before and after running. The results showed that the acidity of the natural copal was considerably reduced by running, but the run copal still had an acid number varying from 67 to 109, depending on the sample.

Due to the acidity of the copal, varnishes made with run copal tend to liver or solidify when mixed with basic pigments, like zinc oxide, to make enamels.

According to Barry[4] the Congo copals, after running, may be esterified on a commercial scale by neutralizing the resin acids with glycerol. The resulting ester is soluble in linseed and other vegetable oils. Varnishes made from the ester have the advantage of a low acid number and resistance to alkalies. Moreover, the varnish films have a hardness and durability of superior quality. It has been reported[5] that Manila copal may also be esterified, but in the literature we found no details of this process.

Recently we investigated the interaction of glycerol and Manila copal. We obtained a product that had not only a low acid number but also a low ester number. It probably consisted mostly of polymerized bodies. However, it proved to be excellent for making durable high-grade varnishes and enamels. Our experiments along this line have therefore consisted principally in determining a suitable procedure for reducing the acidity of Manila copal with glycerol.

EXPERIMENTAL PROCEDURE

The Manila copal used in this investigation was collected by forest rangers and kindly presented to us by Director Tamesis of the Philippine Bureau of Forestry.

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[2] Wolff, H. Farbenztg. 29 (1924) 2039.
Horrmann, P., and N. Kroll. Arch. Pharm. 265 (1927) 214.
Ruzicka, L., and J. R. Hosking. Ann. 469 (1929) 147.

[3] Intengan, C. L., and A. P. West. Philip. Journ. Sci. 75 (1941) 83–95.

[4] Ind. Chem. and Chem. Manuft. (1938) 319.

[5] Ellis, C. The Chemistry of Synthetic Resins 1 (1935) 807, 817.

A number of preliminary experiments were carried out to ascertain the most appropriate conditions for reducing the acidity of Manila copal. First, the copal was run (heated) at a temperature of 315° to 325°C. This process is carried out by gradually melting the copal and continuing to heat it until gases are no longer evolved and the mass subsides and boils gently. The time required to reach this stage is about 1.5 hours, although it varies with the quantity and the sample of copal used. After this condition is reached, heating is continued for about 1.5 hours longer. By heating the copal somewhat above 310°C. the time required to complete the running is reduced. In this running process the temperature is measured by a thermometer inserted into the molten copal.

The acid number was determined both before and after running, by treating approximately 1 gram of the powdered copal with 50 cubic centimeters of a mixture consisting of neutral absolute alcohol and benzene (25 cubic centimeters each) and titrating directly with seminormal alcoholic potassium hydroxide in the presence of phenolphthalein.

Data on the run copal are given in Table 1.

TABLE 1.—*Results of running (heating) Manila copal (decrease in weight and acid number).*

Sample.	Weight.			Acid number.		
	Before running.	After running.	Decrease.	Before running.	After running.	Decrease.
	g.	*g.*	*Per cent.*			
41	150	120	20	133.92	81.37	52.55
42	200	150	25	130.99	79.16	51.83
43	100	85	15	131.60	87.33	44.27
44	150	128	15	107.14	79.49	27.65
45	200	150	25	131.69	76.79	54.90
46	150	120	20	134.97	88.57	46.40
47	100	85	15	106.21	71.96	34.25

NOTE.—The copal was run (heated) at a temperature of 315° to 325°C. for 3 hours.

The loss in weight resulting from the running process varied with the different samples from 15 to 25 per cent. A decrease in the acid number varying from 27.65 to 54.90 was also noted.

Experiments to reduce the acidity of the run copal were carried out, with the use of glycerol as the neutralizing agent. This reaction was facilitated by the presence of a catalyst. Various catalysts were used in preliminary trials. Zinc dust gave the best results.

In Table 2 are given some results on the interaction of run copal and glycerol. Zinc dust was used as catalyst. The samples used and the experimental conditions for running the copal were the same as those reported in Table 1. Accordingly the acid numbers of the run copal (Table 2) were not actually determined, as they were assumed to be the same as those recorded in Table 1.

Immediately after running the copal, glycerol and zinc dust were added and the heating continued for 3 hours more at a temperature of 290° to 295°C. The glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal. After these experiments the acid number was ascertained by dissolving about a gram of the reaction product in 50 cubic centimeters of neutral benzene and titrating the solution with one-tenth normal alcoholic potassium hydroxide. The dilute alkali solution was selected, because the reaction product of glycerol and run copal has a comparatively low acid number.

TABLE 2.—*Reducing the acidity of run Manila copal with glycerol and zinc dust catalyst.*

Sample.	Ingredients.			Acid number.	
	Run copal.	Glycerol.	Zinc dust.	Run copal.	After reaction with glycerol.
	g.	*g.*	*g.*		
41—A	120	12.0	0.60	81.37	16.31
42—A	150	15.0	0.75	79.16	15.42
43—A	85	8.5	0.42	87.33	18.44
44—A	128	12.8	0.64	79.49	13.60
45—A	150	15.0	0.75	76.79	13.68
46—A	120	12.0	0.60	88.57	24.92
47—A	170	17.0	0.85	71.96	10.13

NOTE.—The copal was first run at a temperature of 315° to 325°C. for 3 hours and then immediately treated with 10 per cent glycerol and 0.5 per cent zinc dust catalyst and heated at 290° to 295°C. for 3 hours. The samples (41—A to 47—A) used for these experiments were portions of those (41 to 47) recorded in Table 1.

The acid number of the run copal was greatly reduced after treating with glycerol and the catalyst. In sample 47—A the acid value was reduced from 71.96 to only 10.13. According to Ellis [6] a copal (ester) that has an acid number less than 20 gives satisfactory varnish films that show good resistance to alkalies and are reasonably compatible with basic pigments.

To ascertain if a smaller amount of glycerol could be used for reducing the acidity of run copal, experiments were made with varying proportions of glycerol. The sample of run copal employed for these tests was 47—A (Table 2) which had an acid number of 71.96. Calculated on this figure 100 grams of the run copal would require only 3.93 grams of glycerol to neutralize the free resin acids.

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[6] Chemistry of Synthetic Resins 1 (1935) 819.

The results, recorded in Table 3, show that the lowest acid number (10.13) was obtained when the amount of glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal.

TABLE 3.—*Reducing the acidity of run Manila copal with different proportions of glycerol.*

Glycerol. Grams.	Acid number of reaction product.
3.93	40.38
4.32	29.65
4.71	27.50
5.11	25.14
5.50	23.25
5.89	20.69
6.68	16.14
7.07	16.26
8.05	11.03
10.00	10.13

NOTES.—For every 100 grams of run copal used the amount of zinc dust was 0.5 gram and the weights of glycerol were those recorded in the present table.

Temperature for running copal, 315° to 325° C.
Duration of running, about 3 hours.
Acid number of run copal, 71.96.
Temperature for glycerol reaction, 290° to 295° C.
Duration of glycerol reaction, about 3 hours.

Additional experiments were carried out to ascertain the most suitable conditions for reducing the acidity of run Manila copal to a very low figure. Both the time of running and the duration of the interaction of run copal and glycerol were varied. The data are recorded in Table 4. In these experiments the amount of zinc dust used was 0.5 per cent and the glycerol 10 per cent of the weight of the run copal, except in the reaction with sample 67, when it was 13.33 per cent.

For samples 47—A, 61 to 64, and 67 to 69 inclusive, the temperature of running was 315° to 325° C., and for the glycerol reaction, 290° to 295° C.

For samples 65 and 66 the temperature for running was 310° to 315° C., and for the glycerol reaction, 250° to 260° C.

Samples 47—A and 61 to 69 lost 15 per cent of their weight on running.

TABLE 4.—*Reducing the acidity of run Manila copal by varying both the duration of running and the reaction with glycerol.*

Sample.	Time.		Ingredients.			Acid number of reaction product.
	Running.	Glycerol reaction.	Run copal.	Glycerol.	Zinc dust.	
	Hrs.	*Hrs.*	*g.*	*g.*	*g.*	
61	3.5	3.0	510	51	2.50	5.08
62	3.5	3.0	900	90	4.50	7.21
47–A	3.0	3.0	170	17	0.85	10.13
64	3.0	3.0	170	17	0.85	7.44
65	4.5	2.0	50	5	0.25	7.86
66	4.5	2.0	50	5	0.25	6.88
67	3.0	1.5	128	17	0.60	4.99
68	3.5	1.0	120	12	0.60	6.13
69	3.0	5.0	120	12	0.60	8.69
70	----------	----------	----------	----------	----------	12.02

NOTES.—For samples 47—A, 61 to 64, and 67 to 69 the temperature of running was 315° to 325° C.; and for the glycerol reaction, 290° to 295° C.

For samples 65 and 66 the temperature for running was 310° to 315° C.; and for the glycerol reaction, 250° to 260° C.

Carbon dioxide was passed through sample 64 during both the running and the glycerol reaction; and through sample 66 during the glycerol reaction only. The use of carbon dioxide was expected to give a reaction product light in color. However, the results were about the same as in the other experiments, except that a slightly lower acid number was obtained.

Samples 47—A, 61 to 64, and 67 and 68 were from Tayabas Province; samples 65, 66, and 69 came from Palawan; sample 70 was an imported ester gum.

The data for sample 47—A are also given in Tables 2 and 3.

A review of the results we have obtained (Tables 2, 3, and 4) appears to give the following general conclusions.

In running the copal, before reacting with glycerol, the results are about the same, whether the temperature is 315° to 325° C. for about 3 hours, or 310° to 315° C. for about 4.5 hours. However, it is very important to run the resin thoroughly so as to remove all volatile products.

During the interaction of run copal and glycerol the temperature may be varied from 260° to 290° C. for about 2 hours.

Suitable proportions for the reacting constituents are approximately as follows:

Run copal	100.0 parts
Glycerol	10.0 parts
Zinc dust	0.5 part

These observations are based upon copals we investigated. Since different samples vary considerably in composition, the formulation of general rules is dubious. For instance, we found that the time required to complete the reaction of run copal with glycerol varies from about 1 to 3 hours, depending on the sample.

The glycerol-copal reaction product we obtained was dark brown, very brittle, and transparent. It was soluble in benzene, turpentine, and oils; insoluble in alcohol, ether, chloroform, and alcohol-benzene mixture.

Oil varnishes were made from run copal and also from the glycerol-copal reaction product, the same formula and procedure being used for both preparations. The glycerol-copal varnish was superior to the varnish made from run copal in that it gave a harder, more brilliant and elastic film. It was also more resistant to alkalies and could be mixed with basic pigments, like zinc oxide, without livering or solidifying.

In reacting the copal with glycerol in the presence of a catalyst we obtained a substance with a low ester number; the one from sample 47—A (Table 2) had the constants given below:

Glycerol-copal reaction product:

Saponification No.	26.11
Acid No.	10.13
Ester No.	15.98

These data indicate that the glycerol-copal reaction product contains only a small amount of ester. To find out more about this product we followed a procedure somewhat similar to the method[7] employed for analyzing run copal.

Another sample of the glycerol-copal reaction product (71—B) was prepared as indicated below:

Manila copal (71)
Acid No. 106.02
↓ Heat at 310°–315° C. for 4.5 hours.
Run copal (71—A)
Acid No. 84.27
↓ Add 10 per cent glycerol and 0.5 per cent zinc dust. Heat at 285°–290° C. for 3 hours.
Glycerol-copal reaction product (71—B)

Sap. No.	25.56
Acid No.	7.83
Ester No.	18.73

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[7] Intengan C. L., and A. P. West. Philip. Journ. Sci. 75 (1941) 83–95.

A portion of the copal (sample 71) was heated at a temperature of 310° to 315° C. for 4.5 hours and converted into run copal and the acid number of the run copal determined. Another portion of sample 71 was run as in the previous experiment, and immediately after running there were added glycerol and zinc dust and the heating continued at 285° to 290° C. for 3 hours. The quantity of glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal.

The constants for the reaction product 71—B were similar to those obtained for the glycerol-copal reaction product made from sample 47—A.

Analysis of glycerol-copal reaction product.—This substance was separated into its constituents in accordance with the outline in fig. 1.

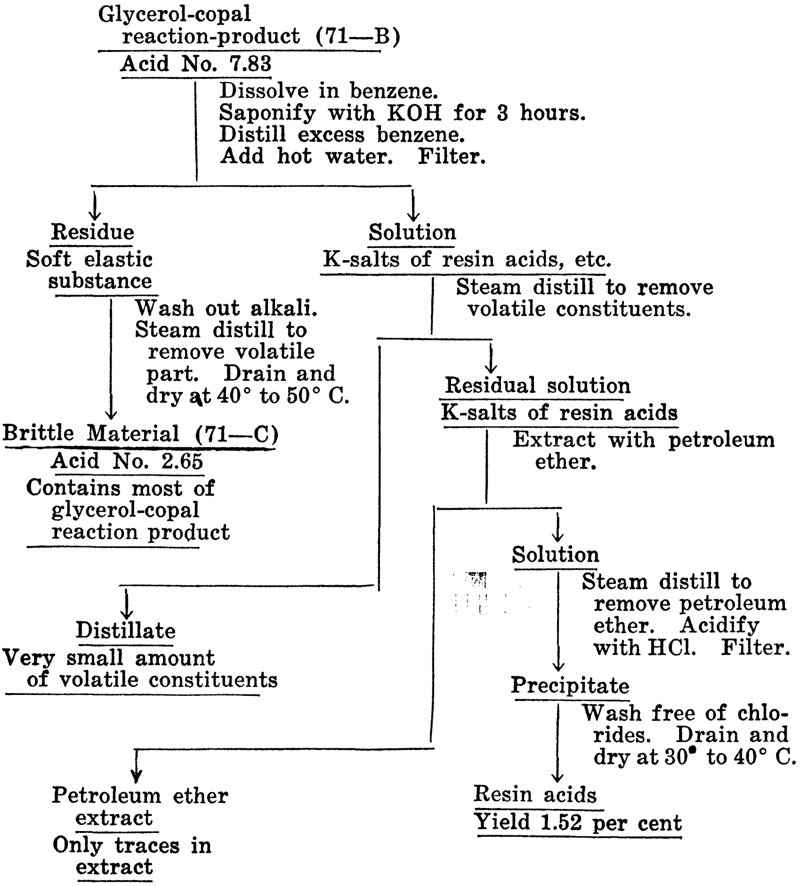
Glycerol-copal reaction-product (71—B)
Acid No. 7.83
Dissolve in benzene.
Saponify with KOH for 3 hours.
Distill excess benzene.
Add hot water. Filter.
Residue
Soft elastic substance
Wash out alkali.
Steam distill to remove volatile part. Drain and dry at 40° to 50° C.
Brittle Material (71—C)
Acid No. 2.65
Contains most of glycerol-copal reaction product
Solution
K-salts of resin acids, etc.
Steam distill to remove volatile constituents.
Residual solution
K-salts of resin acids
Extract with petroleum ether.
Distillate
Very small amount of volatile constituents
Solution
Steam distill to remove petroleum ether. Acidify with HCl. Filter.
Precipitate
Wash free of chlorides. Drain and dry at 30° to 40° C.
Petroleum ether extract
Only traces in extract
Resin acids
Yield 1.52 per cent

FIG. 1. Analysis of glycerol-copal reaction product.

Fifty grams of the powdered glycerol-copal reaction product (71—B) were dissolved in benzene, treated with an excess of alcoholic potassium hydroxide, and heated (reflux) for 3 hours. The excess benzene was removed by distilling, and hot water was added to the residue to dissolve the potassium salts of resin acids. A comparatively large amount of a soft, elastic substance with a characteristic odor separated out. This substance was filtered out and washed to remove alkali, and steam distilled to eliminate any volatile constituents and again washed with water. Finally it was drained and dried at 40° to 50° C. During this drying process the soft substance was gradually converted into a brittle material. Most of the glycerol-copal reaction product was converted into this brittle material which was soluble in benzene and benzene-alcohol mixture, slightly soluble in ether, and insoluble in ethyl and methyl alcohols, petroleum ether, and acetone. It gave the following constants:

Constants of the brittle material, 71—C:

Saponification No.	16.91
Acid No.	2.65
Ester No.	14.26

These constants are somewhat similar to those obtained for the brittle, glycerol-copal reaction product, 71—B.

The filtrate from the residue (soft elastic substance) was supposed to contain the potassium salts of resin acids. It was steam distilled to remove volatile constituents. The ether extract of the distillate showed that only traces of such products distilled over. The residual solution was extracted with petroleum ether. Only traces of material were extracted. After extraction the solution was steam distilled to remove petroleum ether, and acidified with hydrochloric acid. The precipitate, consisting of resin acids (text fig. 1), was filtered and washed free of chlorides, drained, and dried at 30° to 40° C. The resin acids were brittle, dark, and transparent, unlike the amorphous resin acids obtained from run copal.

Only a small amount of these resin acids was obtained (yield 1.52 per cent). This result indicated that the brittle glycerol-copal reaction product (71—B) contained very little glycerol-copal ester. It probably consisted mostly of polymerized bodies (resinous esters) somewhat similar to the alkyd resins.[8]

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[8] Ellis, C., The Chemistry of Synthetic Resins 2 (1935) 862.

SUMMARY

To make oil varnishes with Manila copal it is customary to heat it until the volatile matter has been removed. This heating process is known in the varnish industry as running.

Although the acidity of Manila copal is considerably reduced by running, the run copal still has a rather high acid number (more than 65 in our experiments).

Due to the acidity of the copal, varnishes made with run copal tend to liver or solidify when mixed with basic pigments, like zinc oxide, to make enamels.

In order to reduce the acidity of run copal this product was heated with glycerol in the presence of zinc dust as catalyst. As a result of this reaction the acid number of the run copal was greatly reduced. Usually the reaction product had an acid number less than 20.

The most suitable conditions for reducing the acidity of run copal were obtained when the amount of glycerol was 10 per cent and the zinc dust was 0.5 per cent of the weight of run copal. For running the copal a temperature of about 315° C. for 3.5 hours, and for the glycerol-copal reaction a temperature of about 260° to 290° C. for 2 hours, were satisfactory. However, since different samples of copal vary considerably in composition the formulation of any general rules is dubious.

The glycerol-copal reaction product was dark brown, very brittle, and transparent. It was soluble in benzene, turpentine, and oils; insoluble in alcohol, ether, chloroform, and alcohol-benzene mixture. When analyzed it was found to consist almost entirely of brittle material which was probably polymerized bodies. It gave low acid and ester numbers and contained only a small amount of copal ester and mere traces of other constituents normally present in run copal.

Oil varnishes were made from run copal and also from the glycerol-copal reaction product, the same formula and procedure being used for both preparations. The glycerol-copal varnish was superior to the varnish made from run copal in that it gave a harder, more brilliant, and elastic film. It was also more resistant to alkalies and could be mixed with basic pigments, like zinc oxide, without livering or solidifying.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Analysis of glycerol-copal reaction product.

CALLUS DEVELOPMENT IN GRAFT UNION[1]

By JOSÉ B. JULIANO[2]
Of the Natural History Museum Division
Department of Agriculture and Commerce, Manila

FOUR PLATES

For a long time much of the importance in the regeneration of callus tissue during graft union has been ascribed solely to the activity of the cambium. In fact, even the most modern of our textbooks(2) has overemphasized the rôle of the cambium in graft union. Recently, Sharples and Gunnery(8) illustrated beyond reasonable doubt that in graft union in *Hevea brasiliensis* and *Hibiscus rosa-sinensis* the formation of a callus tissue between the two symbionts, a very important and necessary adjunct to the actual union of the termini of the two cambia, was not of cambial origin. In the present investigation additional evidence is given to further support the findings of these two authors.

This paper deals primarily with the origin and development of the callus tissue in cleft grafting of *Nothopanax* species. These species are very commonly cultivated around houses as hedge plants, and the ease with which they lend themselves to grafting is not unknown to many of our local horticulturists. Having a rather soft bark and not easily forming a large amount of woody tissue, they prove to be very favorable for such study. Besides, grafts from these plants can easily be obtained in the laboratory by the usual horticultural methods.

MATERIALS AND METHODS

Rooted cuttings of *Nothopanax crispatum* (Bull.) Merr. were obtained from the propagating beds of the Department of Agronomy of the College of Agriculture, University of the Philippines, Agricultural College, Laguna Province, February 10, 1939, and planted in tin cans filled with fresh garden soil. They were then allowed to grow in the cans until they had reached a height of about two feet. June 4, 1939, the writer requested Mr. Gavino Rotor Jr.,[3] then graduate assistant in the Division of Horticulture, Department of Agronomy, to graft on the growing plants scions of *Nothopanax cochleatum* Merr., locally known as *platitos*. The method employed in effecting the union was the one ordinarily practised in horticulture.

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[1] This investigation was done in the College of Agriculture, University of the Philippines, where facilities were at the disposal of the writer.

[2] Formerly Assistant Professor of Agricultural Botany, College of Agriculture, University of the Philippines, Agricultural College, Laguna.

Materials for histological study were collected 15 hours after grafting and every day thereafter for 30 days, and on the 33d, 36th, and 54th day. Slabs from both the stock and scion were fixed and killed in formo-aceto-alcohol (70 per cent), prepared according to the formula given by Chamberlain.(1) They were then dehydrated and cleared with the use of butyl alcohol(9) and embedded in paraffin. Sections of 20 to 25 micra were cut and stained either in safranin-Delafield's hæmatoxylin or safranin with light green or aniline blue.[4]

INVESTIGATION

Microscopical examination of the stems used in this study reveals that they possess a rather thick bark consisting of a single epidermal layer on the periphery, made up of parenchyma (Plate 1, fig. 1; Plate 2, fig. 7) with their outer tangential walls covered by a thick cuticle, the continuity of which is broken by the presence of young lenticels, where a distinct meristem is discernible. Below this epidermis is the cortex. On the outer portion of this cortex is a collenchymatous tissue, consisting of from four to six layers. The rest of the cortex is composed of oblong to rounded parenchyma, smaller at the periphery, becoming larger inward, the outer ones of which may possess chloroplastids (Plate 1, fig. 1). These cortical cells usually possess thick or thin cytoplasm.

The phloem region consists of groups of small, isodiametric cells separated by the broad rays from two to five layers thick. The cambium is only conspicuous where the phloem groups are present, whereas in the rays the cambial cells seem to wane away.

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[3] Now graduate assistant in Agricultural Botany.

[4] Credit is due Mr. Potenciano C. Reaño, formerly laboratory helper under the direct supervision of the writer, for cutting and staining the materials used in this study.

The wood portion (Plate 2, fig. 7) is not extensively developed, although secondary thickening has already set in. Traversing the wood are ray cells in rows from one to three cells wide.

The pith occupies the major portion of the stem, and is proportionately larger than the bark and the wood together. It consists of rounded to oblong parenchyma in transverse section, which were smaller around the periphery, becoming larger towards the center. In these cells starch grains are usually found in abundance.

In the preparation of the scion and the stock in grafting, care was taken to make the wounds as smooth as possible. Microscopically, however, the exposed tissue of neither the stock or scion were smooth (Plate 1, fig. 1) when examined 15 hours after grafting. This irregularity may be due either to the dullness of the knife or to the shrinkage of the parenchyma thus killed during the operation, and the slightest shock was perhaps sufficient to kill even some of the cells directly below the cut cells. The latter was more logical cause for this irregularity on the exposed surfaces of both symbionts as utmost care was exercised in the cutting.

The injured cells and some of those lying beneath them lost their moisture and greatly shrunk, even if the wounded areas were covered with budding tape, and their walls became adpressed against the living hypodermal cells. These then formed a dead tissue of some physiological importance to the stem. This death and shrinkage of parenchymatous cells was mostly noticeable in the cortex, phloem, cambial region, and pith (Plate 1, fig. 3) ; that is, wherever parenchyma were present. Cells lying below those that were killed and died remained turgid and retained their original shapes. This phenomenon was more marked in the scion than in the stock.

By the first day after grafting definite activity of the parenchymatous cells near the cut surface was manifest (Plate 1, fig. 5; Plate 3, fig. 13) first in the cortex, and then in the pith (Plate 3, fig. 12). By the 6th day a definite meristematic strip responsible for the regeneration of callus cells had already formed in the bark (Plate 1, figs. 2 and 4). In other words, definite meristematic activity of parenchymatous elements was first exhibited in the bark and then in the pith in both symbionts.

In the bark meristematic activity and consequently the formation of callus tissue was due to the parenchyma below the cut (Plate 1, figs. 2 and 4; Plate 4, figs. 18 and 19). During this active callus development in the bark there was no instance where the writer noticed activity of the cambial cells (Plate 1, fig. 4). If there was any, it may be considered negligible (Plate 1, fig. 2). Parenchyma from the cortex as well as the phloem ray cells were a frequent source of callus tissue in the bark.

In the pith callus was mostly derived from its parenchyma (Plate 3, figs. 9 to 11). Callus formation in the pith seemed to be about equal for both symbionts. Where a woody portion of the scion was exposed in grafting, callus tissue formation was relegated to the ray cells (Plate 3, fig. 9) if present at all; otherwise no definite callus was derived from it (Plate 3, figs. 10 and 11). On the other hand, if the woody portion of the stock was exposed, callus was derived mostly from the scion (Plate 3, fig. 9). If pith from both symbionts happened to touch, there was evidently an equal rate of callus development from both, although initiation of callus activity may have begun with the stock. In the pith initial callus development was first confined near the woody portion, and progressively became active inward. As has been stated above, callus formation was much belated in the pith, so that, while the gap existing between the barks of the two symbionts had already been filled up with callus cushions, that in the pith still remained unfilled with callus tissue. Extra callus cells derived from the bark were usually thrown inward to the interior gap, and progressively infiltrated whatever space remained to be filled up in the interior of the graft (Plate 3, figs. 9 and 10; Plate 4, fig. 16).

The last gap to be infiltrated with callus tissue was in the vicinity of the woods of the two symbionts (Plate 4, figs. 18 and 19), and before, but not after the thirteenth day, from grafting the two symbionts became connected throughout with callus cushion (Plate 4, fig. 14). As soon as the callus tissue between the woody portions of the symbionts had been satisfactorily established, some of the callus cells were transformed into conducting elements (Plate 4, fig. 15) with reticulate thickenings. and they may have been rectangular with their long axes parallel to the cut. These would then establish in the callus cushion a new woody portion which would ultimately connect the woods of the two symbionts.

In case the scion happened to be smaller than the stock, so that the bark of both symbionts only coincided at one side, leaving the opposite side to lie enclosed by the stock, the scion exhibited a quite interesting behavior. Initiation of callus was first noticed around the phloem region, and this activity progressed outward clear to the periphery of the cortex, not excluding the collenchyma layer, and simultaneously a distinct phellogen developed below the epidermis (Plate 3, fig. 8). This combined activity of the meristem in the cortex and that of the phellogen greatly increased the breadth of the bark of the scion in this region of the graft. Concomitant with this activity of the bark of the scion the stock became very active in forming callus tissue which would ultimately enclose the scion (Plate 2, fig. 6).

In longisection of the symbionts callus formation was found to be derived only from the stock if and when the wood of the scion was exposed (Plate 4, fig. 16), and vice versa. The rest of the gap became infiltrated by callus cells derived from the bark. At the region of the split in the stock where the scion was not present (Plate 4, fig. 17), regular wound healing occurred.

Fifty-four days after grafting, when callus tissue had been fully formed between the symbionts, the scion was growing vigorously on the stock and had formed from 4 to 10 new leaves. Internally, however, there was an absence of cambial cells in the callus cushion (Plate 2, fig. 6) which would join the termini of the cambia of the symbionts. It is not within the scope of this paper to further trace the development of callus cells into cambial cells ultimately joining the cambia of the symbionts, but it could be surmised that such development would have taken place if the experiment had been extended further. In this connection Sharples and Gunnery(8) stated that cambial elements in contact with the callus cells on each side of the injury stimulate the adjoining callus cells into active divisions so as to finally form a complete cambial ring. These authors did not, however, try to give definite support to their views, merely stating that new cambial elements did not appear except in close proximity to preexisting cambial elements.

The findings herein presented once more corroborate the findings of Sharples and Gunnery,(8) who stated that the establishment of a cambial bridge across the callused gaps between the symbionts quickly followed the union in *Hevea* and *Hibiscus*. The subject of the origin of callus tissue in grafting operations, either from the cambial elements or from the ray elements, although old, has remained open for discussion up to the present. According to Kostoff,(4) Goppert in 1874 described the joining tissue between the stock and scion as a product of the ray elements, and pointed out that Sorauer rather questioned this statement. Kostoff himself makes no contribution on this point, and simply states that the joining tissue between the stock and the scion was usually the product of the stock. The present study shows that, even if the initial development of the callus tissue should start with the stock, the contributions of both symbionts were more or less equal. Besides, wherever the ray cells or any parenchyma from either symbionts happened to be near the cut surface in grafting operations these elements always became meristematic and participated in the development of the callus cushion. In the importance of ray elements in wound healing as well as in budding, Rutgers(6) and Jimenez(3) recorded the proliferation of ray cells in branch injuries affected by lightning and in stem cuttings of kapok, achuete, and santol, respectively, while Mann and Gunnery(5) indicated the rôle the ray cells played in bud-grafting in *Hevea brasiliensis.*

According to Eames and MacDaniels,(2)

> Among the functions of the cambium is the formation of callus or wound tissue and the healing of wounds. When wounds occur in roots and stems, masses of soft parenchymatous tissue quickly form on or below the injured surface; this tissue, known as callus, may be formed by the division of parenchymatous cells in the phloem and cortex, but its most frequent source is the cambium.

They further state that

> The important practices of budding and grafting have, as their basis, the *ability of the cambium of both stock and scion* to develop callus and unite, thus forming over the union of stock and scion a continuous cambium layer which will give rise to normal conducting tissue. The whole matter of cambium activity and structure in relation to graft union needs further careful study.

It becomes obvious that this idea should be revised in view of the new findings herein presented, coupled with those of other investigators herein cited.

The question of the activity and proliferation of parenchymatous elements from both the bark and the pith in both symbionts in *Nothopanax* spp., the product of which would pack up the gaps between the two symbionts, has been clearly presented. No evidence of any notable cambial participation in the production of callus tissue was noticed, and it may be supposed that this type of tissue regeneration, as had been already presented for *Hevea brasiliensis* and *Hibiscus rosa-sinensis*(8) and in apple grafts,(7) species of unrelated families, would be found to be a common method in woody stems.

SUMMARY

Clear-cut evidence is herein presented to support the view that before union between a stock and scion in cleft grafting in *Nothopanax* spp. is effected, callus cushions are first formed in the gap through the activity of the parenchyma of both the bark and the pith, and the ray cells of both symbionts. From this callus a cambial bridge is derived in joining the cambial ends of the stock and the scion. The mistake of overemphasizing the rôle played by the cambium in callus formation during graft union is brought out.

Although initiation of callus tissue began with the stock, the contribution of the callus by both symbionts was approximately equal. Callus development was usually initiated first in the bark, where proportionately more callus tissue was formed which greatly infiltrated the gap between the two symbionts.

BIBLIOGRAPHY

1. CHAMBERLAIN, C. J. Methods in Plant Histology. Chicago. The University of Chicago Press (1932) 416 pp.
2. EAMES, J. A., and H. L. MACDANIELS. An Introduction to Plant Anatomy. New York. McGraw Hill Book Company (1925) 364 pp.
3. JIMENEZ, P. G. Callus and root formations in stem cuttings of kapok, achuete, and santol. Philip. Agriculturist **26** (1937) 585–635.
4. KOSTOFF, D. Studies on callus tissue. Amer. Journ. Bot. **15** (1928) 565–576.
5. Rubber Research Institute of Malaya. Annual Report, Botanical Division (1928) 39.
6. RUTGERS, A. A. L. Bliksemschade bij Hevea. Arch. v. rubbercult. 3d. yr. (1918) 163–171.
7. SASS, J. E. Formation of callus knots on apple grafts as related to the histology of graft union. Bot. Gaz. **94** (1932) 364–380.
8. SHARPLES, A., and H. GUNNERY. Callus formation in Hibiscus rosa-sinensis L. and Hevea brasiliensis Muell. Arg. Ann. Bot. **47** (1933) 827–839.
9. ZIRKLE, C. The use of n-butyl alcohol in dehydrating woody tissue for paraffin embedding. Science **71** (1930) 103–104.

ILLUSTRATIONS

[All photomicrographs were taken by the photographic studio of the Bureau of Science, Manila.]

PLATE 1

FIG. 1. Portion of a transverse section of the scion (*N. cochleatum* Merr.) 15 hours after grafting, showing unevenness of its exposed surface; *col,* collenchyma; *cp,* cortical parenchyma; *ep,* epidermis. × 64.

2. Portion of a transverse section of the scion (12 days old), showing callus activity mostly derived from the parenchyma of the cortex and very little, if any, from the cambium (*ca*); *cal,* callus tissue; *ph,* phloem; *phr,* phloem ray. × 64.

3. Portion of a transverse section of the stock [*N. crispatum* (Bull.) Merr.], showing shrinkage and death of pith cells 15 hours after grafting. × 64.

4. Portion of the stock, showing callus (*cal*) derived from the bark and its cambium (*ca*) remaining inactive. × 64.

5. Portion of the scion (7 days old), showing development of meristem from the cortical cells; *pf,* phloem fibers. × 578.

PLATE 2

FIG. 6. Transverse section of the symbionts 54 days after grafting; *co,* cortex; *cal,* callus; *l,* lenticel; *inf cal,* infiltrating callus tissue; *pi,* pith; *w,* wood. × 8.

7. Portion of the stock showing its bark and a young lenticel; *ca,* cambium; *cp,* cortical parenchyma; *r,* ray; *ph,* phloem region. × 82.

PLATE 3

8. Portion of a transverse section of the symbionts (scion below), showing activity of the parenchyma near the phloem and cortex, and formation of phellogen (*phe*) below the epidermis; (*ep*) from the scion; *ca,* cambium; *cal,* callus tissue; *col,* collenchyma; *cp,* cortical parenchyma; *ph,* phloem region. × 49.

9. Transverse section of both symbionts, showing activity of the pith cells of the scion (*sc*), of the wood ray cells of the stock (*st*), the infiltrating callus (*inf cal*) cells derived from the bark, and *cal,* callus. × 49.

10. Transverse section of both symbionts, showing activity of the pith cells of the stock (*st pi*), and the infiltrating callus cells (*inf cal*) between; *cal,* callus; *sc pi,* scion pith. × 49.

11. Transverse section of both symbionts, showing activity of the pith cells of the stock (*st*), and the absence of callus formation from the wood of the scion below; *cal,* callus; *sc pi,* pith of the scion. × 49.

FIG. 12. Activity of the pith cells from stock, showing the starch grains. × 226.

13. Initial activity of the parenchyma in the bark of the scion; *cp*, cortical parenchyma; *ph*, phloem region. × 97.

PLATE 4

FIG. 14. Complete infiltration of callus tissue between the symbionts; *cal*, callus; *sc*, scion. × 49.

15. Development of tracheids (*tr*) from among the callus cells between the symbionts; *sc*, scion; *st*, stock. × 49.

16. Longisection of both symbionts, showing the activity of the pith cells (*st pi*) from the stock and the infiltrating callus cells (*inf cal*) between; scion wood (*sc w*) on the right; *cal*, callus. × 49.

17. Longisection of both symbionts, showing the healing of the wound in the stock (*st*) where the scion (*sc*) is absent. × 49.

18. Development of callus tissue (*cal*) from the bark of the scion (below) mostly derived from the cortex and the phloem ray cells. Note the absence of callus from the wood (*w*) and the activity of the pith (*pi*) of the stock above. × 49.

19. Transverse section of both symbionts, showing development of callus (*cal*) from the bark and pith of the stock (*st*); *sc*, scion; *w*, wood. × 49.

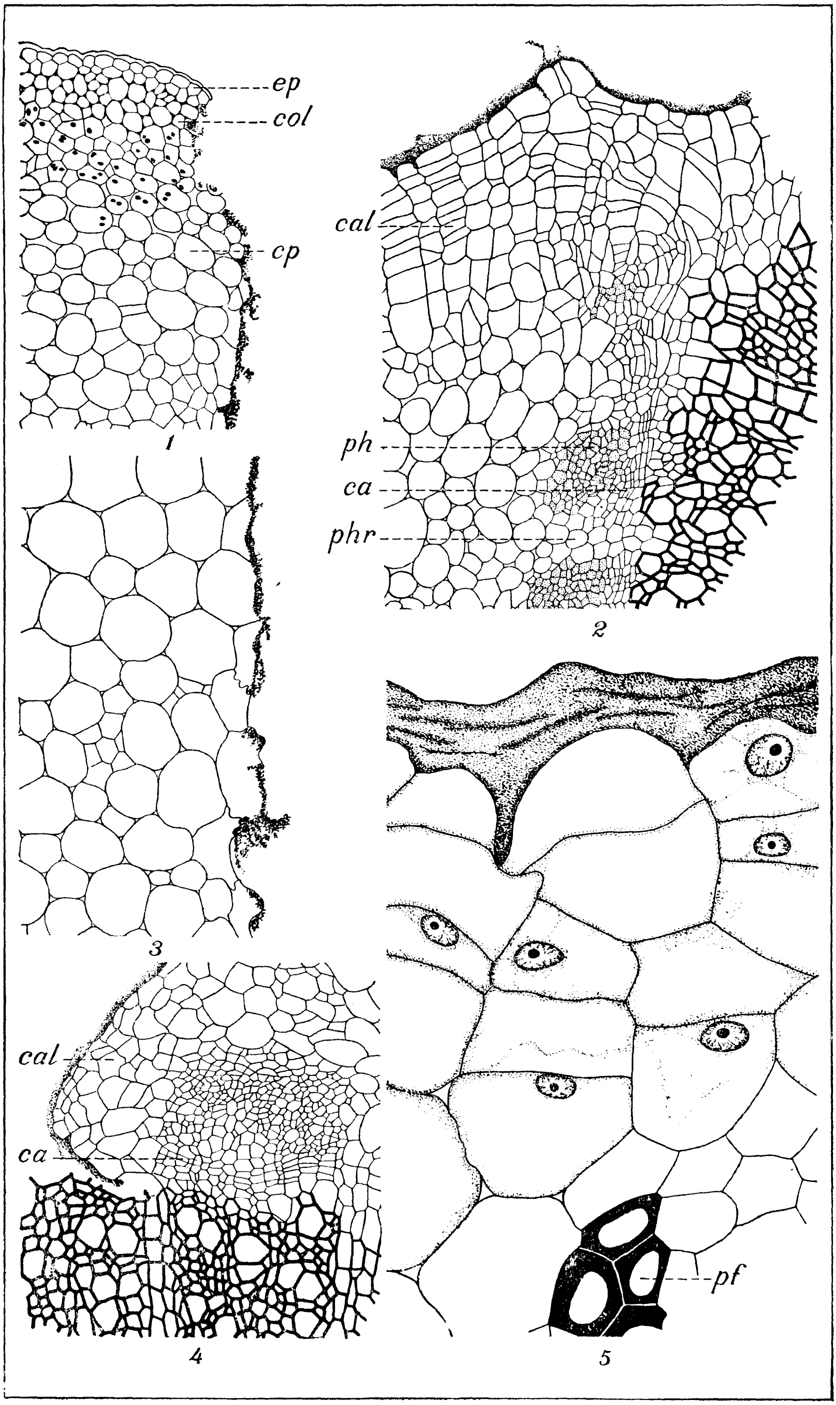

PLATE 1.

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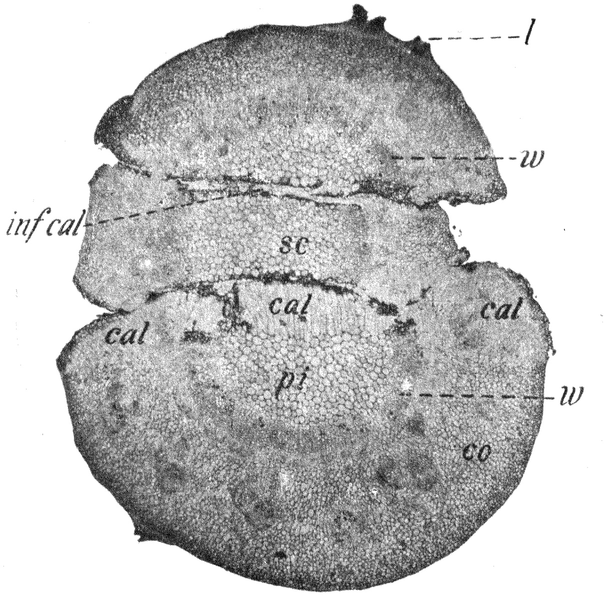

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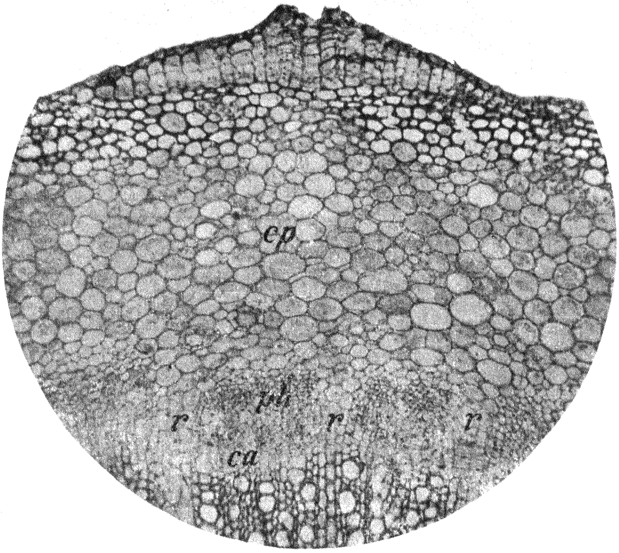

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PLATE 2.

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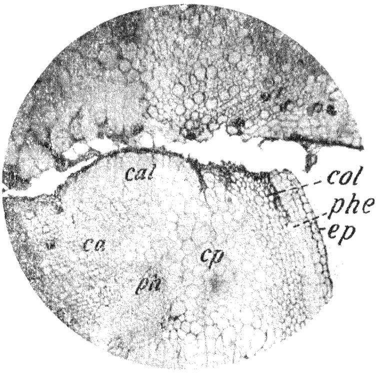

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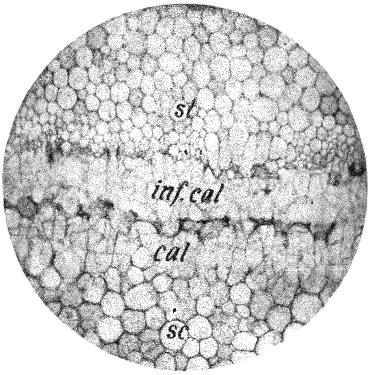

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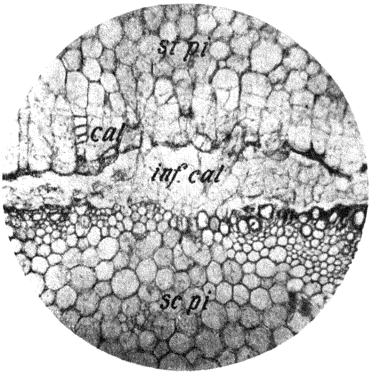

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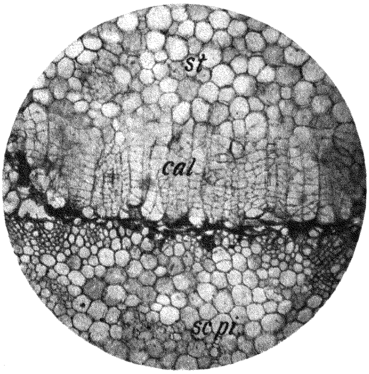

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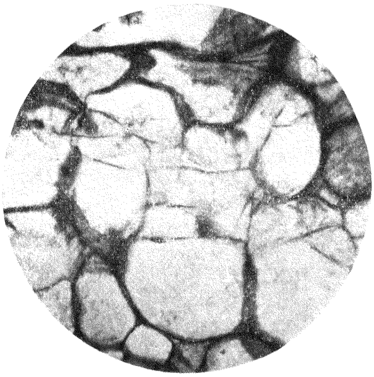

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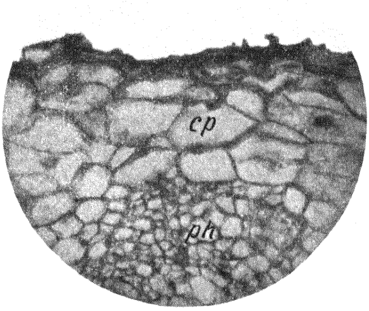

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PLATE 3.

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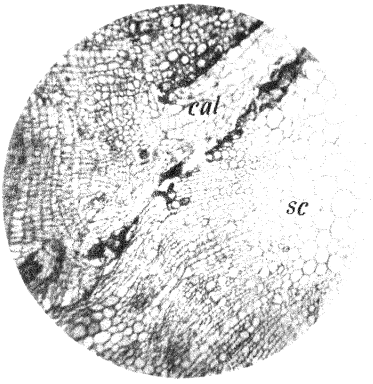

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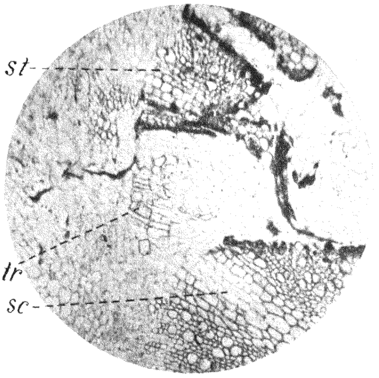

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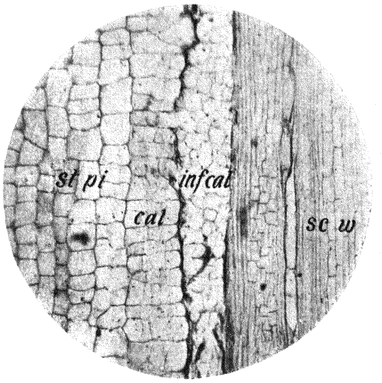

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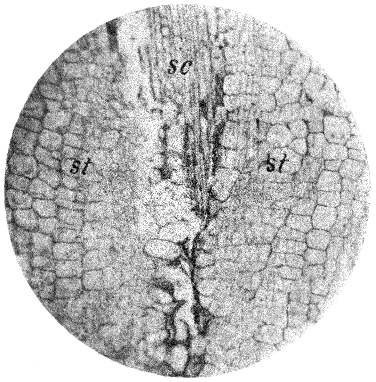

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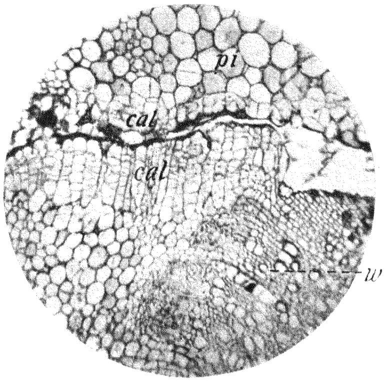

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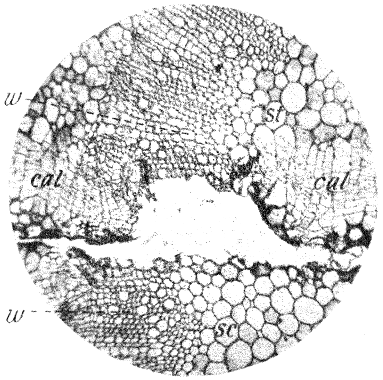

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PLATE 4.

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STUDIES ON THE INFLUENCE OF SPLENECTOMY ON NATURAL AND ACQUIRED IMMUNITY OF RATS TO NIPPOSTRONGYLUS MURIS [1]

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Nine years after Yokogawa(40, 41) described and studied the life history of *Nippostrongylus muris*, Schwartz, Alicata, and Lucker(31) and Africa(1) demonstrated for the first time the resistance of rats to superinfection with this nematode. The former postulated a specific growth-inhibiting substance or substances which delay the development and reduce the egg-laying capacity of the worms, and the latter stated that this condition simulates somewhat the selfcure noted by Stoll(35) in *Hæmonchus contortus* in lambs. The observation on resistance was repeatedly confirmed by more elaborate and extensive investigations of Chandler,(3–10) Spindler,(33, 34) Graham,(15) Porter, (26, 27) Sarles and Taliaferro,(30) and Taliaferro and Sarles.(37) In his first paper Chandler stated that resistance to *Nippostrongylus muris* is not due to a local lethal effect on the nematode in the intestine but to a more general reaction. Because of failure to transfer the immunity passively either by injection or by the use of parabiotic twins, he concluded in his subsequent paper that the immunity is localized in the intestine, claiming that the immune effect is nutritional in nature and possibly due to a development of an antienzyme which affects adversely the activity of the very specialized enzymes by means of which the parasites digest and assimilate the host protein. Later experiments, however, wherein Chandler was able to transfer immunity passively in serum to normal rats, following the work of Sarles and Taliaferro, led him to conclude that general parenteral immunity, like local immunity, is directed primarily against the metabolic products, rather than against the body substance of the worms. In other words, the mechanism of the immunity produced by the worm is closely related to its nutrition.

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[1] Thesis submitted to the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore, in partial fulfilment of the requirements for the degree of Master of Science in Hygiene, June, 1939. The writer wishes to acknowledge the helpful guidance of Drs. W. W. Cort and G. F. Otto during the course of the experiments and the writing of the thesis.

Sarles and Taliaferro(30) considered the mechanism of immunity against *Nippostrongylus muris* as "essentially a local immunity in strategically placed organs, i. e. in the skin, lungs, and intestine and to a great extent has an antibody basis." The statement is based on the finding of stunted and immature worms, and precipitates around and in the gut of the worms in the skin and lungs of immune animals. Sarles(29) extended this investigation on the precipitin of immune serum obtained from hyperimmunized rats and found in *in vitro* experiments the formation of precipitates on the cuticle and on the excretory and digestive systems of the larvæ. These precipitates affected the larvæ by decreasing their activity and inhibiting growth. In a recent paper Taliaferro and Sarles(37) reported an extensive study on the cellular reactions of normal and immune rats after infection with *Nippostrongylus muris,* and noted that up to a certain limit the titer of immunity was directly proportional to the number of larvæ and the number of injections of larvæ given to the rats. In initial and light infections, immunity is mainly manifested in the intestine. In moderately infected rats the immune reactions are noted in the lungs as well as in the intestine. Finally, after many heavy infections, it is manifested in the skin also. In their histopathological studies Taliaferro and Sarles observed stunted worms, larvæ immobilized by precipitates, and active cellular response going to the extent of nodule formations with or without living or dead larvæ. In view of these findings they concluded that the immunity developed in *Nippostrongylus muris* infection is primarily humoral with a secondary cellular cooperation.

It is apparent from what has been given here that acquired immunity to *Nippostrongylus muris* is essentially humoral in nature with a secondary cellular cooperation, the nutritional theory and the specific inhibiting substance or substances which have so far not been demonstrated being probably mere aftereffects. Further, most investigators tend to assume the point of view that the mechanism of immunity against helminths is similar to, if not identical with, that against other infectious agents.

In the studies on the nature and production of resistance to bacterial and protozoan diseases, the attention of various workers during the past several decades has been directed to the rôle played by the spleen. In discussing the varied functions of this organ, Howell(16) states that the spleen takes an active part in the production of antibodies and immune substances.

Perla and Marmorston(25) consider the spleen an organ of macrophage tissue, and thus explain its importance in the mechanism of resistance. Moreover, in reviewing the literature bearing on the spleen's function in antibody formation, they state that definite evidence of fixation of antigen by the spleen occurs, and that in most cases removal of this organ has resulted in the depression of antibody production. In this connection accumulating evidence indicates that the reticuloendothelial system of which the spleen is a part has an important part in the elaboration of humoral antibodies.(36)

Although enlargement of the spleen had been reported in a few instances, namely, in trichinosis,(22) schistosomiasis,(23) and ancylostomiasis,(12) no attempt has been reported in the literature to determine the influence of the spleen in relation to resistance, natural, acquired, or both, in metazoan parasitic infection.

In view of the foregoing it seems desirable to investigate: (*a*) the effect of splenectomy on natural resistance of rats to *Nippostrongylus muris* infection; (*b*) the influence of splenectomy on the production of acquired resistance to superinfection; and lastly (*c*) whether an acquired immunity already established in the body can be broken down by the removal of the spleen in much the same manner as diet and bleeding have been found to alter it.

MATERIALS AND METHODS

Strain of worms used.—The strain used in these investigations was isolated from the wild dump rats (*Epimys rattus norvegicus*) captured in the Westport Dump, Baltimore. The first strain was lost. The second strain obtained was used in the bulk of the experiments performed. The strain was maintained in the laboratory by passing it through laboratory rats at appropriate intervals.

Strain of rats used.—The rats employed in this investigation were from the inbred laboratory piebald rats of the helminthology colony which were reasonably free from worms and were never infected with *Nippostrongylus muris.*

Care of animals.—In most cases the rats were deloused by liberal use of tincture of larkspur. The experimental animals were kept in small perforated galvanized iron cages which measured 9.5 by 9.25 by 15.5 inches, and were provided with removable pans. All cage pans were cleaned and sterilized once a week and the entire cage was placed in a steam sterilizer at frequent intervals. To prevent infestation with lice, bedbugs, or other insects, each cage was supported on four wide-mouthed 4-inch bottles standing in a pan of crude oil. The rats were supplied with an abundant diet prepared according to the formula furnished by the biochemistry department. Occasionally the rats were given fresh cabbage leaves. Clean tap water for drinking was always accessible.

Culture and infection method.—Larvæ were procured by culturing in fæces of infected rats mixed with moist bone charcoal. The larvæ appeared at the surface of the culture within five days, and were quite abundant from the 6th to 12th day. In old cultures stunted larvæ were noted. In general 10-day-old cultures were used and isolated by means of the Baermann apparatus. The larvæ used for injection were washed repeatedly in 50-cc centrifuge tubes and the known number estimated by the dilution count in water suspension, as described by Scott.(32) After thorough stirring an appropriate number was drawn off with a 1-cc syringe armed with a 1.5-inch 19-gauge needle, and injected subcutaneously in the region of the back. To avoid leakage, the point of injection was sealed with celloidin.

Splenectomy.—To test the effects of splenectomy on natural and acquired resistance, the spleens of the rats were removed by surgical means. The technique is briefly described as follows: The animal was anæsthetized by intraperitoneal injection of Nembutal (veterinary) in doses of 0.25 cc of a 1 to 9 dilution with sterile water per 50 grams body weight. The hair of the left flank was clipped close to the skin and rendered sterile by a liberal application of tincture of iodine. A bold incision was made on the skin through the tissues as deep as the peritoneum, and the latter opened with scissors. The abdominal incision was dilated with forceps and the spleen lifted up through the wound with fine tissue forceps, ligated, and severed. One or two kalmerid catgut sutures applied to the abdominal wound completed the operation. Rats subjected to the operation were not used for experiment until 6 days after splenectomy.

Out of the 80 splenectomized, 9 rats, 11 per cent, developed rat anæmia. Probably this figure is lower than the actual condition prevailing in the colony. In all these cases *Bartonella muris* was noted on stained blood smears. In young rats 47 days old and less the condition was not noted. This observation corroborates the finding of Lawkowicz(18) that young rats seem to be free from *Bartonella* infection. However, this finding cannot be taken to mean that young rats are resistant, since Eliot and Ford(13) demonstrated that 3-week-old rats with intact spleen developed anæmia when injected with blood of an anæmic splenectomized rat. Rats found infected with rat anæmia in any set of experiments were discarded with the corresponding number of animals in the control lots, picked at random. Actually 56 rats were employed out of the 80 splenectomized.

Methods of fæcal examination.—To determine the first occurrence of eggs in the fæces after infection or when the modified Stoll counting method failed to reveal eggs in the course of an infection, the Lane direct centrifugal flotation was used. In most of the tests an effort was made to determine quantitatively the number of eggs passed by any animal or group of animals. The Stoll egg-counting technique as modified by Winfield(39) was used for this purpose.

Autopsy methods.—At autopsy the rats were killed with chloroform and the small intestine detached at its union with the stomach and at the junction to the cæcum, removed, and divided into three pieces. These were placed in separate petri dishes, slit open, and worms picked out with fine tissue forceps with the aid of a binocular microscope. At the same time the numbers of male and female worms were determined. The worms collected were preserved and stored in vials.

In some of the experiments the worms in the lungs were roughly estimated by the use of the Baermann apparatus. In experiment 8, after the larvæ were recovered from the lungs by means of the Baermann apparatus, the pieces of lung were examined directly under a binocular microscope for any remaining worms or traces of worms.

EXPERIMENTAL RESULTS

THE EFFECT OF SPLENECTOMY ON THE NATURAL RESISTANCE OF RATS TO NIPPOSTRONGYLID INFECTION

Experiment 1.—Experiment 1 was undertaken to compare the relative egg production and the number of worms in the intestine of nonsplenectomized and splenectomized rats exposed to 420 larvæ administered hypodermically. Table 1 shows that the splenectomized rats had a lower egg count, the maximum being 19,740, observed 10 days after infection. In the nonsplenectomized group the peak of egg production was 31,330 eggs, noted 12 days after infective inoculation. In the actual number of worms collected from the intestine of rats killed 14 days after infection there was an average of 105.5 and 43.5 in nonsplenectomized and splenectomized rats, respectively (Table 2). Twenty-four days after infection an average of 22 worms were recovered from the nonsplenectomized rats and 12.3 worms from the splenectomized animals. There was no difference in the prepatent period in both lots. Twenty-three days after infection the egg count in the nonsplenectomized lot dropped to 1,900 eggs per rat and in the splenectomized group to 430 eggs.

TABLE 1.—*Data from experiment 1, showing the number of eggs from both nonsplenectomized and splenectomized 60-day-old rats, infected with 420 larvæ each.*

Days after infection.	Eggs per day per rat.	
	Non splenectomized.	Splenectomized.
8	[a] +	+
10	27,340	19,740
12	31,330	19,200
14	16,330	15,000
16	20,570	13,170
18	3,410	5,420
21	830	420
23	1,900	430

[a] +, examination by Lane D. C. F. method.

TABLE 2.—*Data from experiment 1, showing the number of worms recovered from both nonsplenectomized and splenectomized 60-day-old rats.*

14 days after infection.					24 days after infection.				
Rat No.	Male worms.	Female worms.	Total worms.	Average.	Rat No.	Male worms.	Female worms.	Total worms.	Average.
NONSPLENECTOMIZED									
1	60	49	109	--------	5	4	7	11	--------
2	46	56	102	105.5	6	17	9	26	--------
					7	11	18	29	22.0
SPLENECTOMIZED									
3	13	4	17	--------	8	4	0	4	--------
4	30	40	70	43.5	9	25	2	27	--------
					10	3	3	6	12.3

TABLE 3.—*Data from experiment 2, showing the number of worms recovered from nonsplenectomized and splenectomized 73-day-old rats exposed to 410 larvæ. Results of autopsy 12 days after infection.*

Rat No.	Male worms.	Female worms.	Total worms.	Average.
NONSPLENECTOMIZED				
1	46	60	106	
2	33	20	53	
3	13	17	30	
4	5	8	13	50.5
SPLENECTOMIZED				
5	25	28	53	
6	10	11	21	
7	14	8	22	
8	18	28	46	35.5

Experiment 2.—Experiment 2 was merely an extension of experiment 1. The dose of infective inoculation was 410 larvæ per rat. No egg count was made. The results were based on the number of worms recovered from the intestine 12 days after infection. The average number of worms collected from the nonsplenectomized group was 50.5, and the number from the splenectomized group was 35.5, a difference of 15 worms. (Table 3). Another point worthy of consideration was the marked difference of the worm burden, especially in the nonsplenectomized group, as demonstrated in rats 1 and 4, with 106 and 13 worms, respectively.

Experiment 3.—Experiment 3 constituted a further extension of the two previous experiments. However, the procedure was varied to the extent that a pair of rats was killed at a time until all rats used in each lot were exhausted. The infective dose was 600 larvæ per rat. Again there was no difference between the prepatent period of the nonsplenectomized and splenectomized rats. The number of eggs per rat per day was greater in the nonsplenectomized rats, except on the 9th day after infection, when 44,000 eggs were recorded in the nonsplenectomized lot as compared with 62,500 eggs in the splenectomized group. The peak of egg production noted on the 16th and last day was 231,500 for the nonsplenectomized rats and 93,000 for the splenectomized animals. Table 4 gives the data from experiment 3.

TABLE 4.—*Data from experiment 3, showing the egg curve and the number of worms recovered from both nonsplenectomized and splenectomized 37-day-old rats, infected with 600 larvæ from a 10-day-old culture.*

Days after infection.	Eggs per day per rat.	
	Nonsplenectomized.	Splenectomized.
7	[a] +	+
9	44,000	62,500
11	--------	--------
13	107,660	76,000
15	138,000	89,250
16	231,500	93,000
18	--------	--------

Days after infection.	Results of autopsy.							
	Nonsplenectomized.				Splenectomized.			
	Male worms.	Female worms.	Total worms.	Average.	Male worms.	Female worms.	Total worms.	Average.
7	--------	--------	--------	--------	--------	--------	--------	--------
9	--------	--------	--------	--------	--------	--------	--------	--------
11	83	104	187	--------	107	117	224	--------
13	92	87	179	--------	75	82	157	--------
15	127	146	273	--------	135	130	265	--------
16	--------	--------	--------	--------	--------	--------	--------	--------
18	151	198	349	247	110	110	220	216.5

[a] +, positive to Lane D. C. F.

Again the splenectomized rats had on the average fewer worms in the intestine. However, in the first pair of rats killed the splenectomized rat had a higher worm burden than the nonsplenectomized animal, the former having 224 worms and the latter 187 worms. In the other three pairs of rats the splenectomized animals had fewer worms than the nonsplenectomized rats.

Experiment 4.—Experiment 4 was an exact duplicate of experiment 3, and the results were essentially similar. The peak of egg output was noted 15 days after infection, 164,400 eggs per rat in the nonsplenectomized lot and 288,750 eggs in the splenectomized group. The smaller number of eggs per day per rat of the nonsplenectomized animals may be attributed to constipation. Table 5 shows that after the peak the nonsplenectomized group carried a higher egg count per day per rat than the splenectomized lot. The last count performed was on the 21st day after infection, the results being 11,450 eggs for the nonsplenectomized and 150 eggs for the splenectomized rats. As in previous tests, the splenectomized group harbored fewer worms than the nonsplenectomized lot. There was an average of 300.4 worms in the nonsplenectomized lot and 228.8 worms in the splenectomized group, the difference being 71.6 worms. The individual variation in the worm burden of the rats was so marked, however, that no significance can be attached to this difference. Table 5 shows the data for experiment 4.

TABLE 5.—*Data from experiment 4, showing the egg curve and the number of worms recovered from both nonsplenectomized and splenectomized 5-day-old rats, infected with 1,200 larvæ from a 10-day-old culture.*

Days after infection.	Eggs per day per rat.	
	Nonsplenectomized.	Splenectomized.
6	[a] +	+
8	18,500	54,500
15	164,400	288,750
16	90,000	64,300
17	80,700	30,700
18	28,600	6,500
19	34,480	750
20	24,850	560
21	11,450	150

Days after infection.	Results of autopsy.							
	Nonsplenectomized.				Splenectomized.			
	Male worms.	Female worms.	Total worms.	Average.	Male worms.	Female worms.	Total worms.	Average.
6								
8								
15								
16	271	340	611		141	170	311	
17	280	340	620		292	360	652	
18	124	35	159		114	12	126	
19								
20	79	1	80		19	0	19	
21	31	1	32	300.4	36	0	36	228.8

[a] +, positive to Lane D. C. F.

Experiment 5.—While experiments 1 to 4 seem to suggest that the splenectomized rats are slightly more resistant to nippostrongylid infection than the normal animals, the results are far from conclusive. Accordingly any such difference may possibly be more clearly brought out by the use of lethal doses of larvæ as a means of gauging resistance of the two groups. As shown in Table 6, 38 rats, from 39 to 47 days old, were used. The results show that the minimum lethal dose was 100 larvæ per gram body weight in both groups. With doses of 100 larvæ per gram the total number of larvæ administered to the rats ranged from 4,200 to 7,600, whereas Porter (26, 27) found 15,000 given percutaneously were required to kill even younger animals. This would suggest that a large number of larvæ are lost in percutaneous infection. In the batch of rats given the above dose (rats 10 NS and S, 11 NS and S, 12 NS and S) the splenectomized animals in general lived longer than the nonsplenectomized individuals. In doses greater than 100 larvæ per gram body weight the rats died one to two days after they were given the test infection. All animals subjected to a dose ranging from 100 to 200 larvæ per gram body weight died from hæmorrhagic verminous pneumonia.

TABLE 6.—*Data from experiment 5, showing relative susceptibility of nonsplenectomized and splenectomized young rats to various doses of larvæ given per gram live body weight.*

Date of infection.	Rat designation.	Age at time of infection.	Weight of rats.	Infective dose per gram body weight.	Total larvæ given.
		Days.	*g.*		
May 3	8 [a] NS	39	56	50	2,800
Do	8 S	39	56	50	2,800
April 12	9 NS	42	44	100	4,400
Do	9 S	42	42	100	4,200
Do	10 NS	42	56	100	5,600
Do	10 S	42	56	100	5,600
April 13	11 NS	46	88	100	8,800
Do	11 S	46	64	100	6,400
Do	12 NS	46	64	100	6,400
Do	12 S	46	76	100	7,600
Do	13 NS	46	70	150	10,500
Do	13 S	46	72	150	10,800
Do	14 NS	46	88	150	13,200
Do	14 S	46	72	150	13,800
Do	15 NS	46	88	150	13,200
Do	15 S	46	94	150	14,100
Do	16 NS	46	88	150	13,200
Do	16 S	46	90	150	13,500
Do	17 NS	46	124	200	24,800
Do	17 S	46	98	200	19,600
April 14	18 NS	47	82	200	16,400
Do	18 S	47	96	200	19,200
Do	19 NS	47	82	200	16,400
Do	19 S	47	92	200	18,400

TABLE 6.—*Data from experiment 5, showing relative susceptibility of nonsplenectomized and splenectomized young rats to various doses of larvæ given per gram live body weight.*—Continued.

Date of infection.	Results.				Killed or died, after infection.
	Nonsplenectomized.		Splenectomized.		
	Larvæ.	Adults.	Larvæ.	Adults.	
May 3					1 month; no autopsy made.
Do					Do.
April 12	67				3 days; intestine not opened.
Do			116		Do.
Do	370				2 days; intestine not opened.
Do			4	1,648	13 days.
April 13	12	433			10 days.
Do			1	1,222	12 days.
Do	30				6 days; intestine not opened.
Do			30	697	8 days.
Do	184				2 days; intestine not opened.
Do			136		Do.
Do	547				1 day; intestine not opened.
Do			541		Do.
Do	271				2 days; intestine not opened.
Do			418		Do.
Do	317				Do.
Do			606		Do.
Do	363				Do.
Do			1,032		Do.
April 14	160				Do.
Do			1,308		Do.
Do	279				Do.
Do			423		Do.

[a] NS, nonsplenectomized; S, splenectomized. Rat Nos. 1 to 7 were omitted, their results being the same as those of Rat Nos. 8 NS and S.

The larvæ isolated from the lungs of the splenectomized group were generally more numerous than those from the nonsplenectomized lot. Rats 9 NS and S and 15 NS and S to 19 NS and S substantiate the above statement. Exceptions, however, were observed, as in rats 13 NS and S and 14 NS and S.

THE EFFECT OF SPLENECTOMY ON THE PRODUCTION OF RESISTANCE TO SUPERINFECTION

Experiment 6.—Experiment 6 was designed to determine whether the production of acquired resistance may be influenced by the removal of the spleen. For the sake of convenience, at the start of the experiment the rats were divided into groups A and B. The initial immunizing dose was 1,200 larvæ, given subcutaneously. The prepatent period was 6 days after inoculation with a 10-day-old culture. The peak of egg production in both lots was 14 days after infection, being 677,200 eggs for the nonsplenectomized lot and 226,000 for the splenectomized group. But the infection died out first in the nonsplenectomized rats. Thirty-eight days after infection no eggs could be recovered by the usual egg-counting method, and on the 45th day the rats were negative by D. C. F. On the contrary, in the splenectomized group the infection persisted, as shown by the egg count performed up to the 45th day. The egg count at this time was 400 eggs per rat. Table 7 gives the data for experiment 6.

TABLE 7.—*Data from experiment 6, egg-curve data from 37-day-old rats exposed to 1,200 larvæ (groups A and B) and reexposed along with group C to 600 larvæ per rat.*

Days after infection.	Eggs per day per rat.		Days after super-infection.	Eggs per day per rat. After 4 days interval.		
	Group A, 5 non-splenectomized rats.	Group B, 5 splenectomized rats.		Group A, 5 non-splenectomized rats.	Group B, 5 splenectomized rats.	Group C, 5 non-splenectomized rats.
6	+	+	6	+	+	+
8	311,200	93,200	7	400	600	2,600
12	268,400	89,200	9	400	600	40,200
14	677,200	226,000	10	400	400	39,400
19	71,200	150,400	12	0	0	88,400
21	193,800	154,400	13	—	+	----------
23	200	1,400	14	200	0	45,800
38	0	3,800	15	200	200	31,600
45	—	400	16	—	—	30,200

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

After a 4-day-interval these two groups, along with a third lot (designated as group C), which were of the same age but previously worm-free and nonsplenectomized, were each given the test dose of 600 larvæ subcutaneously. Six days later all groups were positive to D. C. F. The course of the infection was again followed by the egg-counting method. There was no appreciable difference between the egg output of the splenectomized and that of the nonsplenectomized rats, the readings being 600 and 400 eggs per rat, respectively. Both groups had apparently developed immunity as a result of the initial infection, since in the control lot a peak of 88,400 eggs per rat was reached 12 days after the infective dose. The 16th day both splenectomized and nonsplenectomized groups of immunized rats were negative to D. C. F., while the controls gave a reading of 30,200 eggs per animal. The rats in the three groups were killed and the results of the postmortem examination will be described under a separate heading with those of experiments 7 and 8.

Experiment 7.—Experiment 7 was essentially a repetition of experiment 6, and yielded similar results. The peak of egg production was higher in the splenectomized rats than in the nonsplenectomized animals. This condition may be attributed to constipation, as has been observed in experiment 4. At the peak of egg production, 13 days after the immunizing dose, the egg count was 165,640 for the nonsplenectomized lot and 289,870 for the splenectomized group. As time went by the opposite condition operated up to the 30th day after the immunizing injection. Ten days later the nonsplenectomized group was negative while the splenectomized was still positive to the egg-count method, the reading being 170 eggs, quite identical with experiment 6. After a 7-day-interval a test dose of 600 larvæ was administered to each of the rats along with a control (group F). There was an indication of slightly more eggs produced in the splenectomized group than in the nonsplenectomized lot, but it was of too slight significance to merit consideration beyond passing mention. The peak of egg output in the control lot was 172,200 eggs, the 11th day after the test dose. The results of the necropsy will be incorporated with those of experiments 6 and 8. Table 8 gives the data for experiment 7.

THE EFFECT OF SPLENECTOMY ON ACQUIRED RESISTANCE

Experiment 8.—Experiments 8 and 9 were designed to determine the influence of splenectomy on resistance acquired before splenectomy. In this experiment immunization was produced by a subcutaneous injection of 1,200 larvæ per rat. As shown in Table 9, there was no significant difference in the egg count between the two lots of rats (groups G and H) during the course of the initial infection. Six days after the egg count dropped to 100 per rat, 46 days after infection, the rats of group H were splenectomized. Six days thereafter a test infection of 600 larvæ was given to both groups and to an additional lot of normal controls designated as group I. Six days later the controls were positive, while the other two groups

TABLE 8.—*Data from experiment 7, egg-count data from 47-day-old rats exposed to 1,200 larvæ (groups D and E), reexposed along with group F to 600 larvæ per rat 49 days after initial infection.*

Days after nfection.	Eggs per day per rat.		Days after super-infection.	Eggs per day per rat.		
				After 7 days interval.		
	Group D, 6 non-splenectomized rats..	Group E, 6 splenectomized rats.		Group D, 6 non-splenectomized rats.	Group E, 6 splenectomized rats.	Group F, 6 non-splenectomized rats.
6	[a] +	+	4	—	—	—
7	20,160	55,410	5	170	0	6,500
13	165,640	289,670	8	0	0	126,670
14	90,000	65,670	9	0	0	172,200
15	81,800	30,000	10	—	—	
16	28,000	6,670	11	100	100	78,830
17	34,850	750	12	0	300	19,300
18	24,850	570	13	100	100	4,500
19	11,860	140	14	—	—	2,300
30	500	330				
40	0	170				

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

were negative to D. C. F. On the 8th day the immunized group gave a reading of 400 eggs, the immunized and splenectomized lot, 600 eggs, and the control group 25,000 eggs per rat. Twelve days after the test infection the immunized and splenectomized group was negative to D. C. F., but the immunized lot continued to maintain an egg count of 400 eggs per rat. The peak of egg output of the control animals (group I) was observed on the 13th day with a recorded count of 80,000 eggs per rat. The last egg count showed the immunized groups negative while the control was still passing 15,800 eggs. The result of the necropsy will be included with those of experiments 6 and 7.

After it was clear that no appreciable rise could be expected in the egg curves of any of the groups used in experiments 6 to 8, all the rats were killed and examined for worms in the intestine and larvæ in the lungs. Groups A, B, and C were killed on the 16th day after the test dose, groups D, E, and F on the 14th, and so on, until all 9 groups had been examined. The resulting data are assembled in Table 10, which shows, in the first place, that postmortem data show extreme variation in the number of worms recovered from the intestine, and in this

TABLE 9.—*Data from experiment 8, egg count from 42-day-old rats exposed to 1,200 larvæ (groups G and H), reexposed along with group I to 600 larvæ per rat 53 days after initial infection.*

Days after infection.	Eggs per day per rat.		Days after super-infection.	Eggs per day per rat.		
				After 12 days interval.		
	Group C, 5 non-splenectomized rats.	Group H, 5 non-splenectomized rats.		Group C, 5 non splenectomized rats.	Group H, splenectomized 6 days before superinfection.	Group I, 5 non-splenectomized rats.
6	[a] +	+	5	—	—	—
11	382,400	381,400	6	—	—	+
20	103,000	90,900	8	400	600	25,000
29	1,000	2,770	9	200	0	49,800
35	900	780	10	200	0	37,800
40	100	100	11	0	0	59,800
			12	400	—	55,400
			13	200		80,000
			14	100		19,800
			15	0		15,800

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

respect support previous observations (Chandler and Graham). The worms obtained from the immunized animals, whether splenectomized or not, fell into three categories, namely adult males, undersized adult males and females, and immature forms, some of the latter being hardly a millimeter long. The adult males only were found in both the immunized groups of experiment 8 (groups G and H). The worm burdens of the control rats (groups C, F, and I) are significantly greater than in the other groups, as shown in Table 10. The difference in the worm burden of groups D and E is largely due to one rat in group D which harbored 31 undersized adults and immature forms. This animal had suffered an accident in which the tail was cut and continued to bleed almost all night long. Moreover, because of the blood thirst initiated by the accident, all the rats in this group were restless and cannibalistically inclined up to the termination of the experiment. In experiment 8 there was a difference in the average of worms recovered from groups G and H, suggesting that the removal of the spleen may have altered the degree of immunity established after an immunizing dose of 1,200 larvæ.

TABLE 10.—*Data on worms found in intestines and lungs of reinfected and control rats at autopsy (experiments 6 to 8).*

[B and E, splenectomized and immunized rats; H, immunized and splenectomized rats; A, D, and G, immunized rats; C, F, and I, controls.]

Experiment.	Group.	Days between infection and autopsy.	Number of worms in intestine.						Average.
			Individual autopsy record.						
6	A	16	1	6	35	18	18	------	15.6
	B	16	11	4	13	14	56	------	19.6
	C	16	77	295	150	50	413	------	197.0
7	D	14	9	9	4	[a] 31	3	4	10.0
	E	14	9	2	4	4	1	0	3.3
	F	14	36	3	2	31	57	282	70.0
8	G	15	5	26	34	55	15	------	27.0
	H	15	42	0	33	80	67	------	44.4
	I	15	271	195	107	126	94	------	158.6

Experiment.	Group.	Days between infection and autopsy.	Number of larvæ in lungs.						Average.
			Individual autopsy record.						
6	A	16	3	13	3	2	3	------	4.8
	B	16	3	6	0	5	2	------	3.2
	C	16	0	0	3	0	0	------	0.6
7	D	14	6	11	4	8	13	8	8.3
	E	14	11	13	6	8	11	10	9.8
	F	14	0	4	4	4	3	1	2.6
8	G	15	9	11	16	15	10	------	12.2
	H	15	16	18	19	11	7	------	14.2
	I	15	13	5	6	1	5	------	6.0

[a] Average for group D 5.8 if this animal is omitted (*see* text).

Fewer larvæ were isolated from the lungs of all the control groups than from any of the immunized rats, whether or not the latter had been splenectomized at any time. However, many of the larvæ found in the lungs of the immunized animals either with spleens intact or removed, were in a state of disintegration. More larvæ were obtained from the lungs of the rats employed in experiment 8 than from those in experiments 6 and 7, in which they were recovered by subjecting the lungs for 24 hours to isolation in the Baermann apparatus. In experiment 8 a combined Baermann apparatus and direct binocular examination of the lung tissues thereafter was employed.

Experiment 9.—Experiment 9 was essentially an extension of experiment 8. In determining the degree of resistence already acquired as a result of an immunizing dose of 1,200 larvæ given per rat 52 days previously, lethal doses of larvæ ranging from 21,600 to 33,900 were employed. As shown in Table 11, all rats in the three groups died. In general the immunized and splenectomized rats lived longer than the immunized animals. The control rats, which were of the same age, succumbed earlier to the lethal doses of larvæ than either the immunized rats or the immunized and subsequently splenectomized animals. If delay in the death of an animal may be considered sufficient indication of the degree of immunity, the results presented suggest to a certain extent that the immunized and splenectomized lot showed slightly more resistance than the immunized rats to lethal doses of larvæ. Further, the immunized rats, whether splenectomized or not, offered slightly more resistance than the normal animals. But in no instance was the immunity acquired sufficiently high to prevent death of the experimental animal.

TABLE 11.—*Data from experiment 9, showing the results obtained by testing the degree of immunity produced by a single injection of 1,200 larvæ per rat March 27, 1939, with a lethal dose of 150 larvæ per gram weight, May 19, 1939.*

Rat No	Weight in grams.	Total larvæ in test dose.	Remarks.
IMMUNIZED AND SPLENECTOMIZED			
1	182	27,300	All died within 8 days after infection; no autopsies made.
2	196	29,400	
3	200	30,000	
IMMUNIZED			
4	202	30,300	All died within 4 days after infection; no autopsies made.
5	202	30,300	
6	226	33,900	
CONTROL			
7	172	25,800	All died within 3 days after infection; no autopsies made.
8	156	23,400	
9	144	21,600	

DISCUSSION

Effect of splenectomy on the natural resistance of rats.—From the results presented in experiments 1 to 4 (Tables 1 to 5) no indication suggestive of a decline in the natural resistance of rats against infection of *Nippostrongylus muris* was observed. If the egg production and the number of worms recovered in postmortem examinations are considered sufficiently significant indications in judging resistance, there seems to be enough evidence to show that resistance against nippostrongylid infection is enhanced instead of depressed as a result of splenectomy, contrary to prevailing observations in bacterial and protozoan infections. To a certain extent this observation may find support in the experiments of Lewis and Margot(19–21) who reported an increased resistance in mice against bovine tuberculosis as a result of splenectomy, attributing it to the production of tuberculosplenatin. Further, Tscherikower and Rubinstein(38) stated that there was no lowering of resistance in guinea pigs to infective jaundice induced by injection with *Spirochæta icterogenes* subsequent to splenectomy. Moreover, in experiment 5 (Table 6) the nonsplenectomized and splenectomized rats were subjected to graded doses of larvæ. Once more, in those that received 100 larvæ per gram body weight the splenectomized animals died later than the nonsplenectomized rats, with the exception of rats 9 NS and S, which died on the same day. The lungs of rats 9 S to 19 S were subjected to the Baermann apparatus and hence more larvæ were recorded from the lungs of splenectomized than from those of nonsplenectomized rats. This condition seems to suggest an activation of the septal tissue of the lungs in the production of macrophages in the splenectomized animals in coöperation with the other cellular elements of the body, bringing about retardation at least in the sojourn of the larvæ in this organ. It is a well-known fact that whenever there is a disturbance in the equilibrium of the body tissues there is a corresponding readjustment, not necessarily structural but possibly functional in nature. In this case the changes would seem to be functional, since structural changes resulting from the loss of the spleen in rats require nearly 2 months (Perla and Marmorston) to develop, and marked changes require 6 months.(24) Taliaferro believes that destruction of the reticulo-endothelial system has to be tested within certain time limits, because the system rapidly regenerates due to the proliferation of the cells in other localities. The time limit of 6 days after splenectomy used in various tests here reported is believed to be sufficient margin to preclude the possibility of regeneration and at the same time allow the body to recover from the general depressing effect of the operative trauma and similar factors.

Therefore, if the assumption of the retarding influence of the lungs is correct, the low egg output and the comparatively smaller worm burden in the splenectomized animals as compared with the nonsplenectomized already mentioned, may be attributed to delay in the evolution of the larvæ from the lungs. This delay would incidentally extend the period of maturity of some of the worms and possibly result in a more prolonged infection. It is not unlikely that this state of affairs is actually initiated to a great extent by the adventitious tissue at the seat of injection and at the onset of infection. The greater span of larval life of *Nippostrongylus muris* is spent in the tissues, namely, the skin and the lungs through which it migrates before it settles down in the intestine as a mature parasite to complete its life attached to the mucosa. In view of this peculiarity the defensive mechanism of the host is more or less concentrated for the most part at strategic points in the body where the parasite actually feeds, grows, migrates, and resides. Its inability to multiply suggests a less exhausting and prolonged struggle against the protective forces of the rat than takes place in bacterial infections. In those experiments where the egg count was followed up to 40 days or more after the initial infection, the nonsplenectomized group lost its infection earlier than the splenectomized lot (Tables 7 and 8). This finding further strengthens the postulate of "delay" in the excursion of the larvæ in the various tissues, especially the lungs, provoked possibly by the removal of the spleen. Therefore, the apparent increased resistance as measured by the egg output, worm burden, and possible delay in the death of some of the experimental animals, may be considered relative in character rather than absolute.

Effect of splenectomy on the production of acquired resistance. —Experiments 6 and 7 (Tables 7 and 8) show that there is no significant difference in the egg production and the number of worms recovered from the splenectomized rats as compared with the nonsplenectomized lot (groups A and B, and D and E in Table 10) after a test dose of 600 larvæ. Although in experiment 7 (Table 10) there are three times as many stunted and immature worms on the average in the splenectomized as in the nonsplenectomized rats, this finding is largely due to one rat in group D which had 31 worms. It will be recalled that this animal accidentally had its tail cut off and bled profusely all night. This finding is in accord with the reports of Cort(11) and Foster,(14) who pointed out that the mechanism of resistance to canine hookworms is sometimes broken by repeated bleeding. In general the results presented may find support in the observation of Benario(2) wherein he failed to note any influence of splenectomy on the capacity of mice to develop an acquired resistance to certain poisons, as ricin. Kraus and Schiffman(17) observed that splenectomy had little or no effect on the formation of horse serum precipitin or typhoid agglutinins.

As far as the foregoing experiments went, indications are lacking to substantiate the general opinion among some bacteriologists that splenectomy depresses antibody formation as applied to *Nippostrongylus muris* in rats. Some of the reasons presented in the discussion on the effect of splenectomy on natural resistance may account for the unexpected finding.

Effect of splenectomy on acquired resistance.—Having found that the production of antibodies against nippostrongylid infection of rats is not affected by the removal of the spleen, experiments 8 and 9 were undertaken to determine whether immunity once established in the body of the rats can be broken down in much the same manner as with diet and bleeding. The results recorded in experiment 8 (Table 9) demonstrate that splenectomy did not alter the immunity produced in the experimental animals as far as egg output is concerned. On the other hand, if the average worm burden of groups G and H is considered (Table 10), there is indication that the immunity was to some extent altered by the removal of the spleen. In experiment 9, where the death of the experimental animals was used to measure the intensity of the immunity produced, no marked difference was observed between the two groups. In general the immunized rats, either intact or with the spleen ablated, died later than the control group, suggesting that a certain degree of resistance was developed by a single injection of 1,200 larvæ to the point of prolonging life but not to the extent of preventing death. Perla and Marmoston state that the spleen has no influence on the acquired resistance developed by a previous infection from which the animal has completely recovered; for example, the acquired resistance to *Trypanosoma lewisi* in rats is not affected by subsequent ablation of the spleen.

SUMMARY

A series of experiments to determine the influence of splenectomy on the natural and acquired immunity to *Nippostrongylus muris* of rats was performed. The results obtained show that splenectomy did not reduce the natural resistance of rats to nippostrongylid infection. In fact there seems to be some increase in resistance as a result of splenectomy as shown by the lower egg output, the smaller worm burden, and delay in death

of the experimental animals. The production of immune bodies was apparently not influenced by the removal of the spleen, where the operation was done before immunization. Where the splenectomy was performed after immunization there was only a slight reduction, if any at all, in the degree of immunity.

REFERENCES

1. AFRICA, CANDIDO M. Studies on the host relations of Nippostrongylus muris, with special reference to age resistance and acquired immunity. Journ. Parasit. 18 (1931) 1–13.
2. BENARIO. Ueber den Einfluss der Milz auf die Immunität. Deutsche med. Wchnschr. 20 (1894) 8, 9.
3. CHANDLER, ASA C. Experiments on resistance of rats to superinfection with the nematode, Nippostrongylus muris. Amer. Journ. Hyg. 16 (1932) 750–782.
4. CHANDLER, ASA C. Studies on the nature of immunity to intestinal helminths. I. The local nature of the immunity of white rats to Nippostrongylus infection. Amer. Journ. Hyg. 22 (1935) 157–168.
5. CHANDLER, ASA C. Studies on the nature of immunity to intestinal infection. II. A study of the correlation between degree of resistance of white rats to Nippostrongylus and interval between infections. Amer. Journ. Hyg. 22 (1935) 243–356.
6. CHANDLER, ASA C. Studies on the nature of immunity to intestinal helminths. III. Renewal of growth and egg production in Nippostrongylus after transfer from immune to non-immune rats. Amer. Journ. Hyg. 23 (1936) 46–54.
7. CHANDLER, ASA C. Studies on the nature of immunity to intestinal helminths. IV. The interrelations between parenteral and intestinal immunity in rats infected with Nippostrongylus. Amer. Journ. Hyg. 24 (1936) 129–144.
8. CHANDLER, ASA C. Studies on the nature of immunity to intestinal helminths. V. Experiments on the role of the skin in parenteral immunity and further experiments on passive immunization in Nippostrongylus infections in rats. Amer. Journ. Hyg. 26 (1937) 292–308.
9. CHANDLER, ASA C. Studies on the nature of immunity to intestinal helminths. VI. General resume and discussion. Amer. Journ. Hyg. 26 (1937) 309–321.
10. CHANDLER, ASA C. Further experiments on passive immunity in rats to Nippostrongylus infections. Amer. Journ. Hyg. 28 (1938) 51–62.
11. CORT, W. W. Variations in hookworm disease. Journ. Parasit. 19 (1932) 142–147.
12. CRUZ, W. O. Metaplasia mieloide do baco na ancilostomoso. Mem. de Instit. Oswaldo Cruz 28 (1934) 287–298.
13. ELIOT, C. P., and W. W. FORD. Further observations on the virus of rat anemia with special reference to its transmission by the rat louse, Polyplax spinulosa. Amer. Journ. Hyg. 10 (1929) 635–642.

14. FOSTER, A. O. On a probable relationship between anemia and susceptibility to hookworm infection. Amer. Journ. Hyg. **24** (1936) 109–128.
15. GRAHAM, G. L. Resistance studies with the nematode, Nippostrongylus muris in laboratory rats. Amer. Journ. Hyg. **20** (1934) 352–372.
16. HOWELL, WILLIAM H. A textbook of physiology. W. B. Saunders Co. (1934) 1132 pp.
17. KRAUS, R., and J. SCHIFFMAN. Precipitines et agglutinines. Ann. Inst. Pasteur **20** (1906) 225–240.
18. LAWKOWICZ, W. Researches on Bartonella muris and its cultivation in vitro. Trans. Royal Soc. Trop. Med. & Hyg. **32** (1939) 601–604.
19. LEWIS, P. A., and A. G. MARGOT. Function of the spleen in experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. **19** (1914) 187–194.
20. LEWIS, P. A., and A. G. MARGOT. Function of the spleen in the experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. **21** (1915) 84–90.
21. LEWIS, P. A., and A. G. MARGOT. The function of the spleen in the experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. **22** (1915) 359–365.
22. LUBARSCH, O., and F. HONKE. Handbuch der speziellen pathologischen Anatomie und Histologie. I. Berlin, Verlag von Julius Springer (1927) 1161 pp.
23. NISHIKAWA, T. Zur vergleichenden pathologischen Morphologic der verschiedenen chronischen Milztumoren insbesondere bei Schistosomiasis japonica und morbus Banti. Mitt. d. Med. Fak. de Kaiserl. Univ. zu Tokio **21** (1919) 1–25.
24. PERLA, DAVID. Compensatory changes following splenectomy in Bartonella free rats. Proc. Soc. Exp. Biol. and Med. **31** (1934) 983, 984.
25. PERLA, DAVID, and JESSIE MARMORSTON. The spleen and resistance. Baltimore, The Williams and Wilkins Co. (1935) 170 pp.
26. PORTER, DALE A. A comparative study of Nippostrongylus muris in rats and mice. Amer. Journ. Hyg. **22** (1935) 444–466.
27. PORTER, DALE A. Studies on the effect of milk diet on the resistance of rats to Nippostrongylus muris. Amer. Journ. Hyg. **22** (1935) 467–474.
28. PORTER, DALE A. Studies on the pathology of Nippostrongylus muris in rats and mice. Journ. Parasit. **21** (1935) 226–228.
29. SARLES, MERRITT P. The in vitro action of immune rat serum on the nematode, Nippostrongylus muris. Journ. Infec. Dis. **62** (1938) 337–348.
30. SARLES, MERRITT P., and WILLIAM H. TALIAFERRO. The local points of defense and the passive transfer of acquired immunity to Nippostrongylus muris in rats. Journ. Infec. Dis. **59** (1936) 207–220.
31. SCHWARTZ, BENJAMIN, J. E. ALICATA, and J. R. LUCKER. Resistance of rats to superinfections with a nematode, Nippostrongylus muris, and an apparently similar resistance of horses to superinfection with nematodes. Journ. Wash. Academy Sci. **21** (1931) 259–261.

32. SCOTT, J. ALLEN. An experimental study of the development of Ancylostoma caninum in normal and abnormal hosts. Amer. Journ. Hyg. **8** (1928) 158–204.

33. SPINDLER, L. A. Relation of vitamin A to the development of resistance in rats to superinfections with an intestinal nematode, Nippostrongylus muris. Proc. Helm. Soc. Wash. Journ. Parasit. **21** (1933) 72.

34. SPINDLER, L. A. Resistance of rats to infection with Nippostrongylus muris following administration of the worms by duodenal tube. Amer. Journ. Hyg. **23** (1936) 237–242.

35. STOLL, NORMAN R. Studies with the strongyloid nematode, Næmonchus contortus. I. Acquired resistance of hosts under natural reinfection conditions out-of-doors. Amer. Journ. Hyg. **10** (1929) 384–418.

36. TALIAFERRO, WILLIAM H. The immunology of parasitic infections. New York and London. The Country Co. (1929) 414 pp.

37. TALIAFERO, WILLIAM H., and MERRITT P. SARLES. The cellular reactions in the skin, lungs, and intestine of normal and immune rats after infection with Nippostrongylus muris. Journ. Infec. Dis. **64** (1939) 157–192.

38. TSCHERIKOWER, R. S., and P. L. RUBINSTEIN. Ueber die Bedeutung des retikuloendothelialen Apparates bei Infektionskrankheiten. IV. Das retikuloendotheliale System bei infektiosem Ikterus. Central. f. Bakt. Parasit. und Infek. **114** (1929) 65–68.

39. WINFIELD, G. F. Quantitative experimental studies on the rat nematode, Heterakis spumosa, Schneider, 1866. Amer. Journ. Hyg. **10** (1933) 168–228.

40. YOKOGAWA, S. A new nematode from the rat. Journ. Parasit. **7** (1920) 29–33.

41. YOKOGAWA, S. The development of Heligmosomum muris Yokogawa, a nematode from the intestine of the wild rat. Parasit. **14** (1922) 127–166.

THE ORIGIN OF PLACER GOLD IN SANTA MARIA RIVER, BULACAN

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ONE PLATE

A few years ago, during the exciting days of the mining boom in the Philippines, the writer staked placer claims covering the Santa Maria River and its tributaries in Bulacan Province. Panning showed 30 to 40 good-sized colors per pan, and an occasional flake of platinum. It was then decided to probe the ground with an empire drill. Forty holes sunk in the vicinity of the Santa Maria Bridge showed that the values were mostly confined to the first one or two feet from the surface. There were only occasional colors below that.

In the course of this exploration the creeks were prospected and followed upstream to their sources. The observations made and data obtained, together with the writer's familiarity with the geology of this area,[1] have supplied the material for this short paper.

On following several of the small branches of the Santa Maria River upcreek, their sources were observed to be in the Alat Conglomerate hills (Plate 1). Since these creeks carried gold, and in larger particles than at Santa Maria Bridge, the immediate source was believed to be the Alat Conglomerate. This theory was borne out by the fact that panning the conglomerate in places which suffered no stream action showed an occasional color. The conglomerate of itself was too poor to hydraulic. The streams rising from these conglomerate hills have acted as sluice boxes, concentrating the gold and platinum along the surface, so that panning the material from them gave a goodly number of colors, the size of which sometimes reached that of a housefly's wing.

This fact has also been established in the small creeks south of Norzagaray, in San Jose del Monte, in Sapang Alat, and in

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[1] Alvir, A. D. A Geological Study of the Angat-Novaliches Region. Philippine Journ. Sci. 40 (1929) 359.

Novaliches River. Mariquina River and Angat River carry very little gold because they have ceased to come in contact with the Alat Conglomerate.

The portions of Santa Maria River and its branches east of the Alat Conglomerate carry very little gold, but in the Conglomerate and west of it, the showings are very good. The same can be said of Sapang Alat and Novaliches River.

At Tiakad, near Sapa Biniakdan, north of Mount Tacbuhan, gold can still be panned from the grass roots, near the creek. It will be shown later that the sapa Biniakdan was probably the main Santa Maria River which was flowing westward from the high Sierra Madre Mountains during Pliocene times, that is, during the deposition of the Alat Conglomerate, and was one of the main transportation agents of the gold and platinum now found in the Conglomerate.

CHARACTER OF THE GOLD

The gold found in Santa Maria River and in the other creeks mentioned above occurs as thin flakes, no matter how small the particle. The size varies from a small pinhead to a housefly's wing. The platinum occurs in similar form. In one particle the gold and platinum occurred together, and not merely pounded together, suggesting an ore up in the Sierra Madres in which gold and platinum occur together.

To the flakiness of the gold and platinum is attributed their concentration near the surface. During flood times the river bed is stirred up and the sands settle before do the gold flakes, which swing back and forth in the water, before settling. After the floods many people pan the creeks until the good values along the surface are exhausted.

At Tiakad, mentioned above, the gold is not so flaky, but is a little coarser and more rounded.

ULTIMATE SOURCE OF THE GOLD AND PLATINUM

To understand the ultimate source of the values, it is necessary to consider the geological events which happened during Miocene times and from then up to the present, as well as to have an idea of the Miocene topography and the topographic changes that have taken place up to the present time.

In a previous paper[2] the pre-lava-flow topography of the area east of the Alat Conglomerate in Bulacan Province is discussed. At that time there were clear-cut, regular, straight ridges trending between north-south and north 15° east. Limestone capped these prominent ridges, and shale and sandstones were probably preserved in the valleys. The streams flowed to the south following the depressions, and undoubtedly there were water gaps across some of the ridges, because the general slope of the area was to the west. The upper course of Angat River is in basement complex rocks which were not covered by the Miocene lava flows, so that its present upper course is the regular development from its pre-lava flow bed. The upper Angat River tributaries follow north and south courses in general. Angat River might have been flowing southward in a north-south depression along the lower course of Ipo River, through the present Mariquina Valley, emptying into a former and greater Manila Bay, and Mariquina River may have been one of its branches.

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[2] Alvir, A. D. Ibid. pp. 387, 388.

The Miocene lava flows overran this area and all but drowned it, a few limestone ridges and peaks surviving the flood, being higher than the lava flows. To the west, a limestone ridge hemmed in the lava flow, but to the southwest and south the flow deployed. After the lava flows, therefore, there was a lava plateau which had a natural slope to the west and southwest. We would naturally expect the drainage to flow to the west and southwest from the high Sierra Madre Mountains.

The Pliocene was ushered in by a general submergence in the Philippines, so that the Central Plains of Luzon were occupied by an inland sea. It was during this time that the basal Alat Conglomerates were deposited by the rivers coming from the Sierra Madre and flowing westwardly and southwestwardly over the lava plateau into the inland sea. These rivers, which brought down materials from the Sierra Madre Mountains, also brought down some gold and platinum, especially from the region in and around Angilo Mountains, and Umirey River, which we know is mineralized. This region should also be prospected for platinum.

The gold and platinum grains were incessantly pounded at the beach by the littoral conglomerate motivated by wave action, thus resulting in gold and platinum flakes, instead of rounded grains.

The lower course of Angat River was developed after the lava flow and probably captured its upper courses. Its short tributaries between Ipo and Norzagaray show poor or recent development. The peculiarity of the course of Ipo River is very significant. Its upper course flows westward, in line with Sapa Biniakdan, a branch of Santa Maria River. This is clearly a case of stream piracy, whereby a branch of the Angat River, the lower course of Ipo River, cut off the upper course of Ipo River from Sapa Biniakdan. Post-Pliocene faulting and later development and adjustment of drainage has given us the present pattern, one in which the arteries which supplied gold and platinum to the Alat Conglomerate, have been cut off, except the Angat and Mariquina River systems.

THE CASE OF PAPAYA, NUEVA ECIJA PROVINCE

Samples of placer gold have been submitted to the writer from Papaya, Nueva Ecija Province. The writer has never been to Papaya, but the similarity of the gold flakes, the presence of platinum flakes, and the similarity in topographic position lead him to believe that the origin and history of the Papaya placer deposits are very much the same as those of Santa Maria, Bulacan, and that the basal Pliocene Alat Conglomerates are present in Papaya.

ILLUSTRATION

PLATE 1

Aerial geologic map of the Angat-Novaliches region.

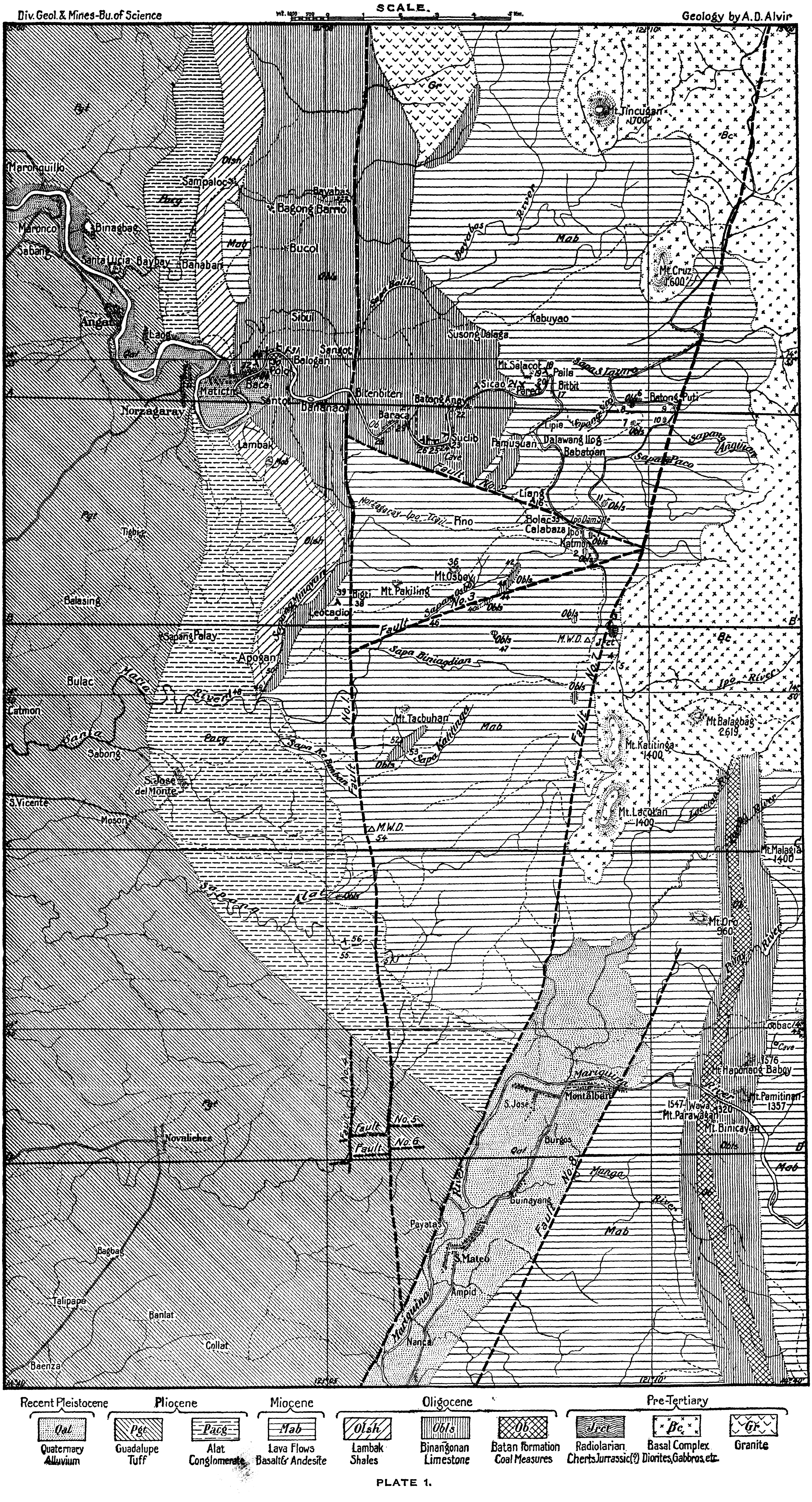
SCALE.
Div. Geol. & Mines-Bu. of Science
Geology by A. D. Alvir
Maronquillo
Maronco
Binagbag
Sabang
Santa Lucia Baybay
Angat
Lado
Sampaloc
Bahabari
Bayabas
Bagong Barrio
Bucol
Sibul
Sangot
Bologan
Polo
Bace
Haticti
Santol
Norzagaray
Bitenbiten
Dananao
Lambak
Baraca
Batong Anga
Sucib
Cave
Susong Dalaga
Kabuyao
Mt. Tincugan 1700
Mt. Cruz 1600
Mt. Salacot
Paila
Bitbit
Sicao
Pared
Lipie
Batong Puti
Dalawang Ilog
Babatoan
Pamusuan
Sapang Anguian
Sapang Paco
Sapa Salaguin
Bayabas River
Sapa Bolilo
Liang
Bolac
Celabaza
Ipo Dam Site
Ipo
Katmon
Norzagaray-Ipo Trail
Rino
Mt. Osboy
Mt. Pakiling
Bigti
Leocadio
Fault No. 2
Fault No. 3
Fault No. 1
Fault No. 7
Fault No. 4
Fault No. 5
Fault No. 6
Fault No. 8
Sapa Biniagdian
Sapang Minayang
Sapang Palay
Apogan
Bulac
Catmon
Santa Maria River
Sabong
S. Jose del Monte
S. Vicente
Moson
Tigbiz
Balasing
Mt. Tacbuhan
Sapa Kalitinga
Sapa Ke Bamban
Sapa Caysapalong
M.W.D.
Alat
Ipo River
Mt. Balagbag 2619
Mt. Katitinga 1400
Mt. Lacotan 1400
Lacotan River
Mt. Malagia 1400
Mt. Oro 960
Puray River
Loobac
Cave
Mt. Haponang Baboy 1576
Mt. Pamitinan 1357
Wawa
Mt. Parawagan
Mt. Binicayan
Mariquina River
Montalban
S. Jose
Burgos
Manga River
Guinayang
Payatas
S. Mateo
Ampid
Nanca
Novaliches
Bagbag
Talipapa
Banlat
Collat
Baenza
Recent Pleistocene
Pliocene
Miocene
Oligocene
Pre-Tertiary
Qal Quaternary Alluvium
Pgt Guadalupe Tuff
Pacg Alat Conglomerate
Mab Lava Flows Basalt & Andesite
Olsh Lambak Shales
Obls Binangonan Limestone
Ob Batan Formation Coal Measures
Jrct Radiolarian Cherts Jurrassic(?)
Bc Basal Complex Diorites, Gabbros, etc.
Gr Granite

PLATE 1.

PRELIMINARY NOTES ON A TREMATODE WITH TWO YOLK RESERVOIRS AND A NEW SPECIES OF LECITHOCHIRIUM

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TWO PLATES

The present study is a continuation of an investigation started by myself on the parasitic fauna of the Puget Sound collections from the Oceanographic Laboratories at Friday Harbor, Washington, during the summer of 1938. One of the hosts, *Sebastodes elongatus* Ayres, was caught in the vicinity of the Laboratory float; the other host, *Sebastodes ruberrimus* Cramer, was taken east of San Juan Island. The trematodes harbored by these fishes were found to belong to rather widely separated families, Opecœlidæ Ozaki (1925) and Hemiuridæ Lühe (1901), respectively. I wish to acknowledge here my obligation to Dr. John Guberlet for his kindly assistance and for the use of his library; and to Miss Edna Lou Grout for assistance on the drawings.

Family OPECOELIDÆ Ozaki

Two mature specimens of this fluke were taken from the mucosa of the rectal portion of the intestine of a rook cod, *Sebastodes elongatus* Ayres, collected below the Cantilever pier at the Oceanographic Laboratories, Friday Harbor, Washington, July 17, 1938. They differ from the already known members of the family Opecœlidæ in having two yolk reservoirs and in the complete inclosure of the seminal vesicle within the cirrus sac. They are therefore placed in a new genus, for which the name *Dideutosaccus* is proposed.

Body small, elongate, flattened, tapering towards anterior end, 3.5 to 4 mm long and 0.45 to 0.5 mm in maximum width across anterior testis. Cutile fairly thick, smooth, and thrown into folds in contracted specimens. Preacetabular region 0.4 to 0.45 mm. Postacetabular region 2 to 2.5 mm. Posttesticular region 0.62 mm. Suckers small; ventral sucker twice as large as oral. Oral sucker subterminal, 0.15 by 0.14 mm. Ventral sucker sessile, almost ovate, 0.36 by 0.27 mm. Prepharynx absent; pharynx somewhat fusiform, muscular, 0.015 by 0.007 mm. Œsophagus short, 0.006 by 0.002 mm. Intestinal crura simple, without lateral branches, uniting at posterior end to open on ventral surface near posterior extremity.

Excretory pore terminal. Excretory vesicle tubular, running forward through testicular region to about posterior margin of anterior testis. Two fine branches arising from the rather enlarged anterior end.

Testes almost ovate, one behind the other on the median line; posterior testes larger than anterior organ. Anterior testis 0.19 by 0.27 mm. Posterior testis 0.28 by 0.26 mm. Seminal receptacle anterodorsal to ovary, short-ovate, cirrus small, muscular and pyriform, 0.06 by 0.04 mm, inclosing elongate, tortuous seminal vesicle and pars prostatica. External seminal vesicle absent. Genital pore sinistral, at level of pharyngoœsophageal junction.

Ovary ovate, median, overlapping anteroventral surface of anterior testis, 0.11 by 0.24 mm. Two oblong yolk reservoirs present, one on each side of anterior border of ovary. Cotype and Mehlis glands anterior to ovary, between yolk reservoirs. Uterine coils intercæcal, between shell gland and acetabulum. Metraterm short and muscular. Laurer's canal present. Eggs 0.07 by 0.03 mm. Vitelline follicles extending from behind posterior margin of acetabulum to posterior extremity of the body and uniting behind testis.

Host.—*Sebastodes elongatus* Ayres.

Location.—Rectum.

Locality.—Friday Harbor, Washington.

Type species.—Acena Helminthological collection No. 34.

Genus DIDEUTOSACCUS novum

Opecœlidæ: Body elongate, tapering towards anterior end. Cuticle smooth. Acetabulum sessile, larger than oral sucker, at posterior portion of first fourth of body length. Œsophagus very short. Genital pore sinistral, at level of pharyngoœsophageal junction. Cirrus sac small, pyriform, inclosing long tortuous seminal vesicle and prostate. External seminal vesicle absent. Testes tandem, postovarial, postequatorial. Ovary ovate, immediately anterior to testes. Seminal receptacle anterodorsal to ovary. Vitellaria in small follicles, extending from behind ventral sucker to posterior end of body. Two yolk reservoirs present, anterodorsal to ovary, united mesially by a common duct. Eggs fairly large, not numerous. Intestinal parasites of marine fish.

Type species.—Dideutosaccus radifistuli sp. nov.

HEMIURIDÆ

LECITHOCHIRIUM MEDIUS sp. nov. Plate 2.

Six worms of this species were found in the stomach of a red snapper, *Sebastodes ruberrimus* Cramer, taken at Friday Harbor, Washington, from about 70 feet of water east of San Juan Island.

Lühe (1901) established the genus *Lecithochirium* with *Lecithochirium rufovirida* (Rudophi) as the type species. A distinct feature separating *Lecithochirium* from the very similar genus, *Sterrhurus* Looss (1907), is the presence of a presomatic pit with an underlying cell pad. The genus also includes *L. gravidum* Looss, *L. excisum* Rudolphi, *L. excisiforme* Cohn, *L. synodi* Manter, *L. psenopsis* Yamaguti, *L. magnacetabulum* Yamaguti, *L. pagrosomi* Yamaguti, *L. japonicum* Yamaguti, and *L. exodicum* MacFarlane.

Body with tail appendage either wholly or partly retracted, 2.5 to 3 by 0.65 to 0.74 mm, widest at level of posterior half of acetabulum. Cuticula smooth. Appendage with rings. Preacetabular region 0.65 mm. Posttesticular region, 0.45 mm. Ventral sucker sessile, equatorial, about two and one half times size of oral sucker. Oral sucker without internal elevations. Preacetabular pit median, with pads of cells underlying it. Pharynx present, elliptical. Œsophagus very short. Intestinal cæca simple, not extending into tail appendage. Excretory pore terminal in tail appendage. Excretory vesicle V-shaped. Genital pore sinistral, at level of pharyngoœsophageal junction. Testes, ovary, and vitellaria characteristic of the genus. Seminal vesicle greatly convoluted, leading directly into the pyriform pars prostatica. Seminal vesicle reaching posteriorly to about midportion of ventral sucker. Cirrus sac small, muscular, pyriform. Ovary elliptical, 0.22 by 0.12 mm, behind and in contact with posterior testis. Vitellaria compact; lobes rounded. Yolk reservoir present, small, ovate, 0.08 by 0.01 mm, posterodorsal to ovary and between vitellaria. Uterus never entering tail appendage. Metraterm muscular, long. Laurer's canal present. Eggs numerous, small, 0.03 by 0.01 mm.

Host.—Sebastodes ruberrimus Cramer.

Location.—Stomach.

Locality.—East of San Juan Island, Washington.

Type species.—Acena Helminthological collection No. 23.

L. medius differs from *L. synodi* Manter (1931) and from *L. microstomum* Chandler (1935) in the relative ratio of the suckers and in the forms of the seminal vesicle and the pars prostatica, and from *L. exodicum* MacFarlane (1936) in the size of the eggs.

REFERENCES

ACENA, SERGIO P. A new genus and three new species of Digenetic Trematodes from Puget Sound Fishes. M. S. Thesis (1940) 1–70, 7 pls. 12 figs.

CHANDLER, ASA C. Parasites of fishes in Galveston Bay. Proc. U. S. Nat. Mus. (2977) **83** (1935) 127, 128, 1 pl., 2 figs.

LLOYD, L. C. Some digenetic trematodes from Puget Sound fishes. Journ. Parasit. (2) **24** (1938) 103–133, 4 pls., 35 figs.

LOOSS, A. Beiträge zur Systematic der Distomen. Zool. Jahrb. Syst. **26** (1907) 64–80.

MACFARLANE, S. H. A study of trematodes from marine fishes of Departure Bay, B. C. Journ. Biol. Board Canada **2** (1936) 335–347.

MANTER, H. W. Some marine fish trematodes of Maine. Journ. Parasit. **12** (1925) 11–18.

MANTER, H. W. Some digenetic trematodes from deep water fish of Tortugas, Florida. Carnegie Inst. Wash. Publ. No. 435, Papers Tortugas Labontoy **28** (1934) 261–345.

ILLUSTRATIONS

[Legends: *an*, anus; *eg*, egg; *exp*, excretory pore; *exv*, excretory vesicle; *gp*, genital pore; *int*, intestine; *lc*, Laurer's canal; *m*, metraterm; *œ*, œsophagus; *oomg*, ootype and Mehlis glands; *os*, oral sucker; *ov*, ovary; *pap*, preacetabular pit; *par*, parenchyma; *ph*, pharynx; *pr*, pars prostatica; *sr*, seminal receptacle; *ss*, sinus sac; *sv*, seminal vesicle; *t*, testes; *ut*, uterus; *vs*, ventral sucker; *vit*, vitelline glands; *yg*, yolk glands; *yr*, yolk reservoir.]

PLATE 1

FIG. 1. *Dideutosaccus radifistuli* gen. et sp. nov.; whole mount, ventral view.

2. Semidiagrammatic reconstruction of genital complex of *Dideutosaccus radifistuli* sp. nov.

3. *Dideutosaccus radifistuli* sp. nov. Reconstruction of the terminal genital ducts.

PLATE 2

4. Egg of *Lecithochirium medius* sp. nov.

5. *Lecithochirium medius* sp. nov.; whole mount, ventral view.

6. *Lecithochirium medius* sp. nov., reconstruction of terminal genital tract.

7. *Lecithochirium medius* sp. nov., reconstruction of genital complex.

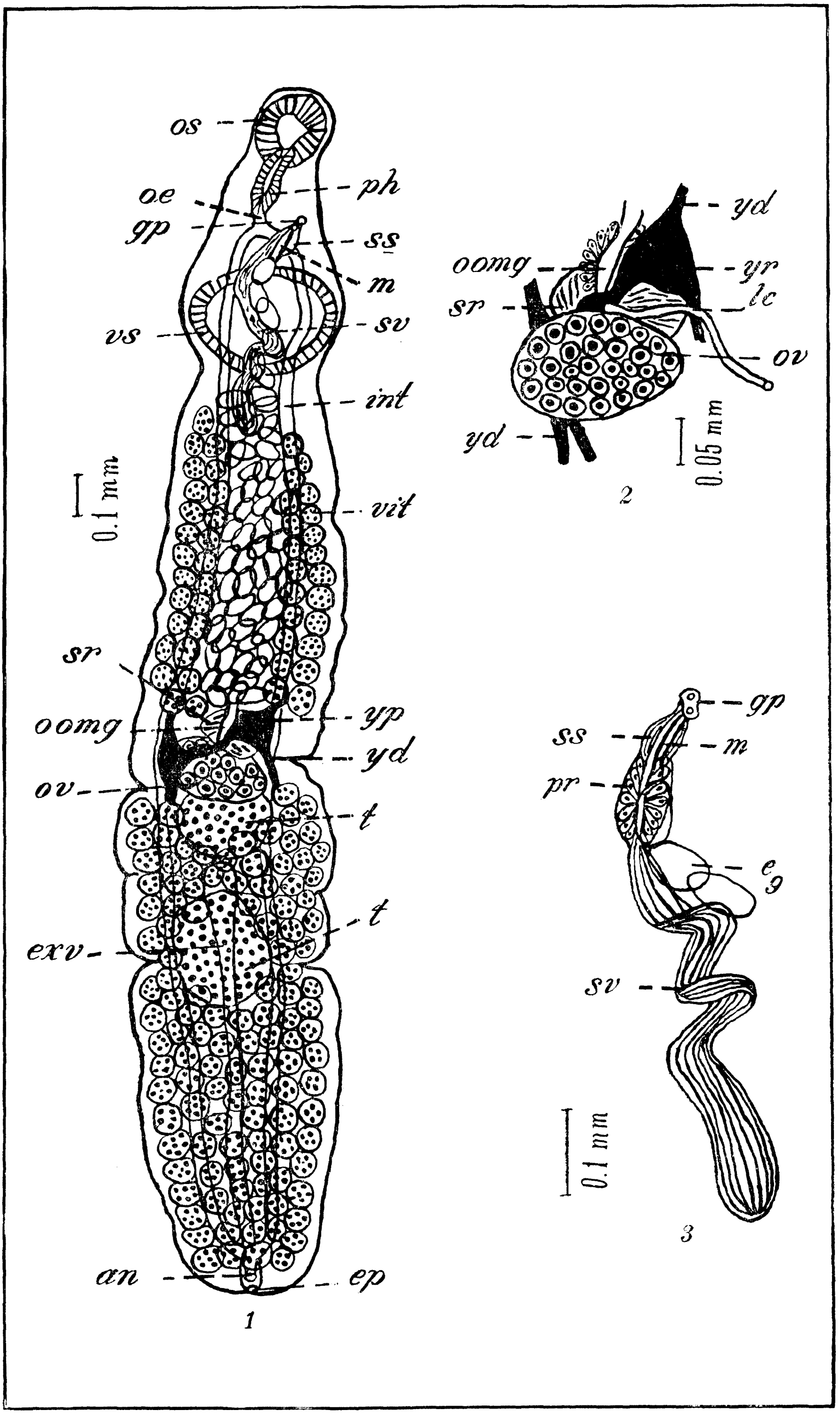
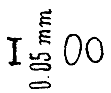


PLATE 1.

UNIV. OF MICH.



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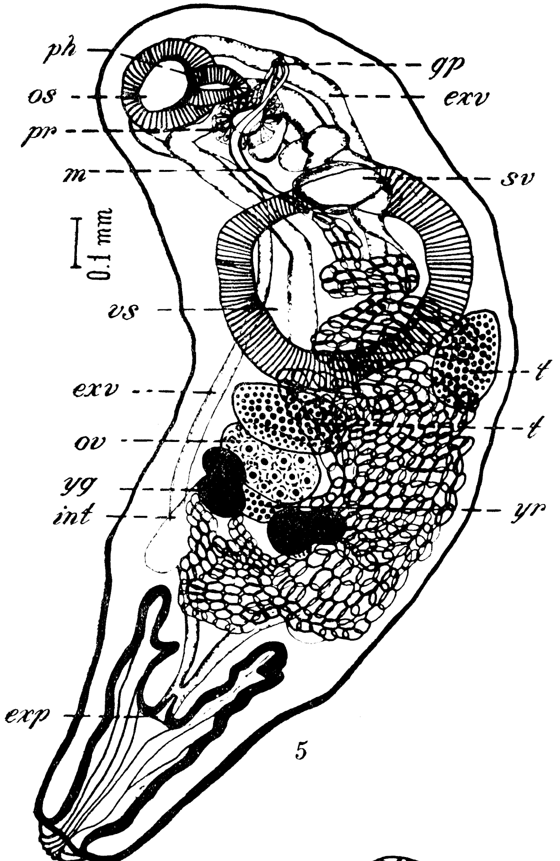

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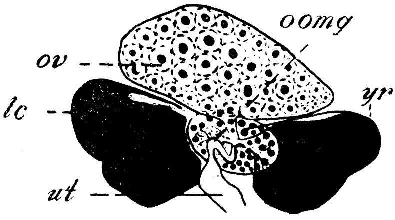

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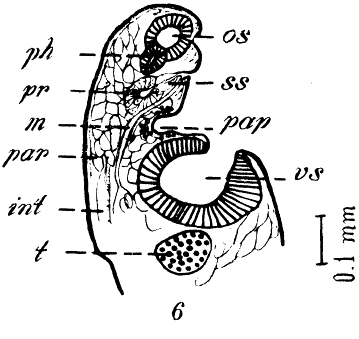

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PLATE 2.

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TYPES OF WATERCRAFT IN THE PHILIPPINES

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THIRTEEN PLATES

The geographical structure of the Philippines, with its innumerable navigable rivers, bays, gulfs, and seas; the difficulties of land transportation in the rural districts during seasons of heavy rainfall; the temporary character of the roadbeds and the makeshift bridges which are often carried away by the swollen streams; the lack of sufficient funds for repairs and for new construction of roads—all these conditions favor the use of diverse types of watercraft in the Philippine Archipelago. Most of the watercraft are considered native, but there are not a few foreign types which have proved useful in the Islands' domestic as well as foreign trade. Of the latter types the steamships and the sailboats stand first in importance.

The boats used by the ancient Filipinos were extraordinarily large and carried 100 rowers and about 30 or 60 fighting men. These were of East Indian and Oceanic origin. The large boats were built of planks, while the smaller craft were simply hewn-out logs and, when new, absolutely leak-proof. All but the smallest canoes were provided with outriggers—stout bamboos or light logs extending parallel with the hull but held at some distance from it by a bamboo frame. The outriggers prevented the boat from capsizing. Wooden pegs and rattan lashings held the parts together. On the larger vessels, generally used for fighting, a platform raised above the middle length of the hull supported the fighters, and an awning of mats protected them from the heat of the sun and, to a slight extent, shielded them from view and thus from the arrows and spears of their enemies. The mast, which in former times probably consisted of matting of buri or pandan leaves, could be lowered or raised with the sail. Wide paddles, instead of rudders, were used for steering. The craft was very shallow, so that even the larger boats could be drawn up on shore at night. With such vessels the

Moros long practiced piracy and contested control of the southern seas and islands with the Spaniards.

It is the prime object of this paper to give a description of the different types of watercraft in use in the islands since the time of their discovery. The list, arranged in alphabetical order to give facility for reference to those who are interested in their study, includes a few obsolete types which have ceased to be useful as means of water transportation.

Almadia (*almadie*).[1]—A small native fishing boat mentioned by Antonio Pigafetta in his *Primo Viaggio Intorno Al Mundo* between 1519 and 1522. The name is derived from the Spanish word *almadia,* a sort of canoe used by the inhabitants of the East Indies. It also refers to a boat used by the Portuguese and their slaves in the East Indies. Used in crossing rivers.

Balandra (*sloop*).[2]—A coasting or light sailing vessel with one mast. Mentioned by Jesuit Father Juan de Zarzuela June 19, 1691, in Extracts from Jesuit Letters.

Balsa (*raft*).—A floating platform, usually composed of wooden logs, planks, or bamboos, or the like, fastened together by nails, spikes, cordage, or rattan, and used for the carriage of goods and passengers. Logs and bamboos transported to the market are often made into rafts to facilitate their transportation. In all probability the balsa was the first man-made device for travel on water. Balsas have been in use by all peoples since prehistoric times. Common at present in Abra, Batangas, Isabela, and other provinces. (Plate 1, figs. 1 and 2.)

Banca (*vanca*).[3]—A kind of Philippine canoe, made from a hollowed tree trunk, like the American dugout. Sometimes provided with outriggers to prevent it from capsizing. Often roofed with thinly split bamboos and trestlework of buri or nipa leaves, called *carang* in Pampangan. In use up to the present, principally in navigable rivers, lakes, and creeks, and to some extent in bays or gulfs, for fishing or for the transportation of goods from one place to another. Common in Pampanga, Bulacan and other Provinces, and in Manila. (Plate 2, figs. 1 and 2.)

Bancon.[4]—A boat with three oars on each side of the hull. Of Chinese origin. Said to be used by the Chinese in minor depredations along the coasts of the Philippines. Appeared in the islands sometime in 1635–1636, when the Portuguese were trading at Manila.

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[1] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898 **33** (1906) 213, 315.

[2] Op. cit. **41** (1906) 35.

[3] Op. cit. **4** (1903) 184.

[4] Op. cit. **25** (1905) 118.

Barangay (*balanghai, balanguai, barangaye*).[5]—The most primitive and the most characteristic boat in the Philippines. Described by historical writers as "a sharp slender craft, pointed at both ends, and put together with wooden nails and pegs." Propelled by oars and sails. The name of this boat was later taken to mean a group or social organization composed of a family or a group of families known as *barangayes;* thus was preserved the remembrance of the conveyance by which their forefathers reached the Islands. As the various families came hither, each in its own barangay—all during the voyage under the command of a *cabeza* (a head captain or pilot)—the land was partitioned among them, subject to their respective cabezas (later known as *datus* or *maguinoos*) who directed them on the sea. The barangay was used between 1576 and 1582, during the expedition to Borneo, Jolo, and Mindanao. Particularly common in Cagayan and Isabela. (Plate 4, fig. 1.)

Barca chata.[6]—A flat-bottomed boat capable of carrying heavy loads. Generally used for artillery. Mentioned by Antonio de Morga in his Sucesos in 1609.

Barcoluengo.[7]—An oblong boat with a round bow, its only mast being in the center. Usually provided with sailors, soldiers, ammunition, and provisions necessary for at least a year's voyage, and a cosmographer, skillful in geometrical tables, for accurate recording on map or chart of new discoveries. Used in establishing a way station for Philippine vessels on the California coast, in 1605–1609.

Bark (*barca*).[8]—Formerly a small sailing vessel, as a pinnace or fishing smack. Also a rowboat, or a three-masted vessel, having foremast and mainmast square-rigged, and mizzenmast fore-and-aft rigged. Mentioned in The Agustinians in the Philippines, 1670–1694.

Baroto (*baloto, boloto*).[9]—A sort of dugout used mainly as a lighter, for unloading larger vessels. Sometimes more than 80 feet long. This type of vessel was used by Governor Francisco de Sande in his expedition to Borneo, Jolo, and Mindanao in 1576–1582. Common in Capiz, Cebu, Surigao, Ilocos Sur, and Tayabas Provinces.

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[5] Op. cit. 4 (1903) 184.

[6] Op. cit. 16 (1904) 50.

[7] Op. cit. 14 (1904) 183.

[8] Op. cit. 42 (1906) 118.

[9] Op. cit. 4 (1903) 197.

Batel.[10]—A type of vessel provided with sails, oars, and a rudder. Used in navigable rivers and quiet seas. Generally loaded with goods and merchandise. This type of vessel is commonly used in Batangas and Tayabas Provinces.

Bigniday (*biguiday, biniray*).[11]—A vessel resembling a prao, a large banca, or the *binitan.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo (1519–1522).

Bileg.[12]—A native boat in Ilocos Norte Province, used at sea. It is similar to the *virey.*

Bilis (*bilus*).[13]—A baloto (canoe dug out of a single log), 20 varias [14] long. Its hull alone is called *dalámas.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo (1519–1522).

Binitan.[15]—Formerly made by the people of Catanduanes. For more detailed description *see viroco.*

Brigantine.[16]—A piratical vessel or any light swift vessel used in the Mediterranean and the Levant. Also a two-masted, square-rigged vessel, differing from a brig in that she does not carry a square mainsail. Mentioned in the Expedition of Miguel Lopez de Legaspi (1521–1569).

Canoa (*canoe*).[17]—A dugout scooped out of a single tree trunk and holding one or two persons. Mentioned in De Moluccis Insulis (1493–1529). Common in most islands.

Cañonero (*gunboat*).[18]—A light steam vessel with a steel hull and of 20 to 30 horse power, constructed in England for the Spaniards for use against the Moro pirates. Very effective in reducing Moro piracy in Lake Lanao district, Mindanao, and in adjacent islands in 1670–1700. Mentioned in Jolo and the Sulus from Charles Wilke's Narrative of the United States Exploring Expedition.

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[10] Op. cit. **19** (1904) 60.

[11] Op. cit. **33** (1906) 239.

[12] Census of the Philippine Islands: 1903. **4** (1905) 589.

[13] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **30** (1906) 343.

[14] One vara equals 0.85 meter.

[15] Op. cit. **16** (1904) 107.

[16] Webster New International Dictionary of the English Language (1938) 336.

[17] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **1** (1903) 322.

[18] Op. cit. **43** (1906) 185.

Caracoa (*carcoa*).[19]—A large canoe used by the Malays. Provided with two rows of oars, very light, and fitted with a European sail, its rigging of native manufacture. Mentioned in the Negotiations between Legaspi and Gonzalo Pereira, Commander-in-chief, regarding the Spanish settlement at Cebu sometime in 1568–1569.

Carangail.[20]—A vessel of the Moro pirates which attacked the Spaniards at Jolo, and plundered the Pintados (Bisayans) at Oton, Cebu. Mentioned in Pintados Menaced by Mindanao Pirates (1599–1602).

Caravel (*carabela*).[21]—A small vessel of the 15th and 16th centuries with broad bow, high, narrow poop, three or four masts, and usually lateen sails on the two or three aftermasts. Columbus had two caravels with him on his great voyage. The name also refers to a Portuguese vessel of 100 or 150 tons. Mentioned in the Treaty of Tordesillas in 1493–1529.

Casco.[22]—A long almost rectangular barge or lighter, sometimes with sails. Principally used for loading merchandise. Very common in the islands. (Plate 4, fig. 2.)

Chalana (*scow*).[23]—A large flat-bottomed boat, having broad, square ends, chiefly used as a lighter or for transporting refuse to its place of disposal. Found mostly in Manila, Cavite, and Olongapo. (Plate 5, fig. 2.)

Chalupa (*shallop*).[24]—A light, open boat used chiefly on rivers. Propelled by oars or sails or by both. Usually provided with two masts carrying fore-and-aft sails or lugsails. It appeared in the Philippines in 1521–1569.

Champan (*sampan*).[25]—A Chinese vessel described by Retana as being "about as large as a Spanish *patache*, but inferior to the junks of the Chinese. It is used by the Chinese for trading in the Filipinas Islands." The term is now applied to a boat 12 or 15 feet long in which a family often makes its home on the

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[19] Op. cit. 2 (1903) 246.

[20] Op. cit. 11 (1904) 297.

[21] Op. cit. 1 (1903) 124–126.

[22] Webster New International Dictionary of the English Language (1938) 414.

[23] Op. cit. p. 445.

[24] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 11 (1904) 158.

[25] Op. cit. 5 (1903) 194.

Canton River. Mentioned in Juan Bautista Roman's letter to the Viceroy in 1582–1583. (Plate 6, fig. 1.)

Cho.[26]—A kind of craft used in Philippine waters, the sails of which are made of rushes. It is a weak vessel, plying in China Sea, usually loaded with slaves, pepper, and various kinds of cotton cloth. Used in 1627.

Cris-craft (*speedboat*).—A very fast boat made of planks propelled by a motor of great power. It is used only in sports and for pleasure trips; because of the high cost of construction and maintenance only the rich can afford to buy it.

Cutter.—A broad square-sterned boat for carrying stores and passengers, either rowed, sailed, or propelled by engines. Also a vessel with one mast, rigged in most essentials like a sloop, although usually with a reefing bowsprit and topmast. It is narrower and deeper than a typical sloop. At present the commonwealth government is using cutters for official trips.

Dapang.—A swift light vessel of the Samal Moros similar to the vinta which sails in and out of the hundreds of reefs and islands composing the Sulu Group.

Falua (*faluca, felucca*).[27]—A small, open boat, or a long boat with oars. Also a narrow, fast, lateen-rigged vessel, commonly three-masted, chiefly used in the Mediterranean. It is usually low with an awning in place of an upper deck, and with provision for the use of oars when necessary. Mentioned by Father Francisco Mastrili in the Conquest of Mindanao in 1636–1637. (Plate 7, fig. 1.)

Ferryboat (*passage boat*).—A vessel for conveying passengers, merchandise, and other cargo across a river or other narrow bodies of water. Also a boat which carries passengers from Manila to the port of Cavite (Plate 6, fig. 2).

Filipote (*flyboat*).[28]—Formerly a large flat-bottom coasting vessel or a round sailing vessel. Now a kind of fast passenger or freight boat used on canals in England. Mentioned in Formosa Lost to Spain 1640–1649.

Fisolere (*fucelere, fusiniere*).[29]—A small and very swift oared vessel, used in winter on the Venetian lakes by the Venetian nobles for hunting with bows and arrows and guns. Mentioned by Antonio Pigafetta in his Primo Viaggio Intoro Al Mundo 1519–1522.

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[26] Op. cit. 22 (1904) 186.

[27] Op. cit. 27 (1905) 256.

[28] Op. cit. 35 (1906) 135.

[29] Op. cit. 33 (1906) 232.

Fragata (*frigate*).[30]—A light vessel propelled by sails and oars. Supplied with men and provisions. Mentioned in the Account of Expedition to Borneo and Jolo, Mindanao (1576–1582).

Funea.[31]—From the Japanese *funé* which means 'boat.' This may be etymologically equivalent to the English word 'funny' a small, clinker-built, narrow rowboat. Mentioned in Morga's Sucesos de las Islas Filipinas in 1609.

Fusta.[32]—A small vessel with lateen sails. During the expedition of Ruy Lopez de Villalobos in 1521 this type of vessel was equipped with ammunitions, artillery, weapons, and provisions.

Gabarra (*barge*).[33]—A roomy boat, usually flat-bottomed, used principally in harbors and on rivers and canals for the conveyance of passengers or goods. The name also refers to a pleasure boat elegantly furnished. Mentioned in Relation to Events in the Filipinas Islands 1629–1630.

Galizabra.[34]—A vessel with lateen-rigged sails, used in the Levant trade. Its name is of Arabic origin. Mentioned in Military affairs of the Islands (1597–1599).

Galleon.[35]—A huge, round-stemmed, clumsy vessel with bulwarks 3 to 4 feet thick and built up at stem and stern like castles. Also a sailing vessel of the 15th and following centuries. Often having 3 or 4 decks, and used for war or for commerce by the Spaniards as treasure ships in their American trade (particularly between Mexico and Manila). Usually of from 1,200 to 1,500 tons burden, and carrying 50 to 60 guns. The latter, however, for lack of space, were generally banished to the hold during the eastward voyage. Homeward, with plenty of space to spare, the guns were remounted. The galleons by instruction wore the royal flag, although some were put under foreign colors. The officers were commissioned and uniformed like the officers of the Spanish navy, and the ships were under the same regulation and discipline. Mentioned in the Historical Introduction of the Philippine Islands by Edward Gaylord Bourne 1493–1529 (Plate 7, fig. 2).

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[30] Op. cit. 4 (1903) 156.

[31] Op. cit. 15 (1904) 118.

[32] Op. cit. 2 (1903) 60.

[33] Op. cit. 23 (1904) 89.

[34] Op. cit. 10 (1904) 213.

[35] Craig, Austin. The former Philippines through foreign eyes (1931) 64.

Galley (*galera*).[36]—A large, low, usually one-decked vessel, propelled by both oars and sails, used through the Middle Ages, especially in the Mediterranean, for war, trading, ceremonial, and pleasure purposes. The typical war galley of the Mediterranean was from 100 to 200 feet long, often having 20 oars on each side with two or three rowers to each oar. It had 2 or 3 masts rigged with lateen sails, carried guns at prow and stern and a complement of as many as 1,000 to 1,200 men. Very efficient in Mediæval warfare. This type of vessel was mentioned in the Expedition of Villalobos in 1521–1569.

Garay.[37]—An ancient sailboat or a long canoelike boat with two outriggers and with 40 or 60 oars. Used by the Moro pirates from Sulu, particularly the notorious Balangingi Samals. Equipped with lantacas, spears, krises, and barongs. An expedition is officered by the following: (*a*) the *nakura,* who is the commander: (*b*) the *julmuri,* who acts as first mate, in charge of the crew (*sakay*), watches the boat for leakage, and controls the rudder (*bausan*); (*c*) the *julbato,* who is in charge of the anchor (*sao*), guards the prow, and keeps a lookout for reefs, rocks, and enemy ships. The booty generally consists of slaves, jewelry, and silver and gold coins. Slaves and goods were allotted in kind, or sold and the proceeds divided along with the money booty. Division was made among the officers and crew according to rank and work after the shares of the sultan and the *panglima* or datu has been set aside. (Plate 8, fig. 1.)

Goleta (*schooner*).[38]—A fore-and-aft rigged vessel having two masts, with the smaller sail on the foremast, and mainmast stepped nearly amidship. Mentioned in Remarks on the Philippine Islands, and on their Capital Manila, 1819–1822. (Plate 8, fig. 2.)

Guilálas.—A vessel made of planks used in navigable rivers for loading merchandise. Similar to the casco or the barangay. Formerly common in some parts of the islands.

Houseboat.[39]—A covered boat used as a dwelling. Carved from a single log 40 to 50 feet long and 6 feet or more in diameter. Usually a large flat-bottomed boat with a superstructure much like a house. Used for cruising along quiet waters on sea or rivers. Mentioned in Portuguese and Spanish Expedition Against the Dutch, 1615. Common also in southern waters. (Plate 9, fig. 1.)

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[36] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 2 (1903) 49.

[37] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 64.

[38] Funk & Wagnall's New Standard Dictionary of the English Language (1929) 1052.

[39] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 17 (1904) 264.

Jañgua.[40]—A small, armed vessel like a raft. Mentioned in the Conquest of the Molucas Islands by Bartolome Leonardo Argensola in 1609.

Joañga (juañga).[41]—A flatboat. According to Retana and Pastells the name is derived from the Chinese word *chun,* which means 'boat'. Regarded as a small junk. Mentioned in Morga's Sucesos, 1609.

Junk (junco).[42]—A characteristic Chinese vessel having as common features, bluff lines, very high poop and overhanging stem, little or no keel, and polemasts, usually very high, carrying lugsails or round sails woven out of palm fibers with battens running entirely across. The leech of the lug is often much curved and the rudder usually drops below the keel. Impelled by the wind only when it blows directly fore-and-aft. Mentioned in De Moluccis Insulis. Common in the islands in 1493–1529. (Plate 9, fig. 2.)

Kurikanan.—A small, swift, and very light fishing boat, usually paddled by one or two men. Furnished with outriggers and sail. Common in Batangas and Mindoro.

Lampitaw.[43]—A small boat still in use in the Philippines. According to Rizal, the word *lopis,* another type of boat, is a transformation of the Tagal word *lampitaw.* Mentioned in Morga's Sucesos de las Islas Filipinas in 1609.

Lancan.[44]—A type of boat usel by the ancient Christian Filipinos in Mindanao. Similar to the *prao* or *parao* and used in rivers and bays. Mentioned in a letter written by Father Pablo Pastells to the Father Provincial, Juan Capell., S. J., in 1887.

Lancha (launch).[45]—A small vessel navigated with sails and oars; or an open undecked boat of any size driven by steam or other power, used as a pleasure craft or for carrying passengers short distances. Common in Manila, Sorsogon, and Samar. Used in establishing a way station for Philippine vessels on the California Coast in 1605–1609.

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[40] Op. cit. 14 (1904) 238.

[41] Tom. cit. 54.

[42] Op. cit. 1 (1903) 305.

[43] Op. cit. 15 (1904) 90.

[44] Op. cit. 43 (1906) 273.

[45] Op. cit. 14 (1904) 183.

Lapis.[46]—A roomy vessel used to carry merchandise. For a more detailed description *see tapaque.*

Lipa.[47]—A passenger boat of the Mohammedan Moros, made at the Tawitawi Islands. It is usually longer and slower than the other Moro boats and constructed without outriggers. It is built up from canoes by the addition of planks upon the sides.

Longboat.[48]—A large boat carried by a merchant sailing vessel, corresponding to the sailing launch of a naval vessel. Mentioned in the Affairs in Filipinas in 1644–1647.

Lorcha.[49]—A Chinese vessel, lighter and swifter than the junk, using oars and sails. Mentioned in Morga's Sucesos de las Islas Filipinas in 1609. Common in Capiz, Cebu, Sorsogon, and Leyte.

Lunday (*lunde*).—A banca or dugout without outriggers. Used in fishing and for passenger transportation without cargo. Very common in the islands.

Mangcuerna.[50]—A vessel used chiefly in transporting merchandise in La Union Province. Used on quiet seas and navigable rivers. Propelled by oars only.

Mosca.[51]—A French vessel which had been captured by the parish priest of Batangas, Fray Melchor Fernandez, together with the dispatches carried on that vessel. Mentioned in Representation in the Spanish Cortes, 1801–1840.

Pailebote.—A boat in which pilots cruise offshore to meet incoming vessels. It is usually a strong, fast, weatherly boat, now sometimes using steam. Common in ports of call.

Panco (*prao*).[52]—A vessel of the Moro pirates with extraordinary swiftness. Made of planks lashed together with rattans, without sail or any other ligature. Its masts consisted of three bamboos, its rigging of a few pieces of rattan or the bark of trees, its sails of *petates* or mats, called *saguran.* Some of those vessels used in piratical expeditions were large and fitted out with 50, 100, or sometimes 200 men. The shots of their scanty and defective artillery were very uncertain, because they generally carried their guns suspended on slings. These men, however, were dexterous in the management of the campilans. Mentioned in the Reforms in Filipinas 1801–1840.

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[46] Op. cit. **9** (1904) 296.

[47] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 16.

[48] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **35** (1906) 262.

[49] Op. cit. **14** (1904) 57.

[50] Census of the Philippine Islands: 1903 (1905) 282.

[51] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **51** (1907) 282.

[52] Op. cit. **43** (1906) 273.

Pangue.[53]—A native boat particularly used in rivers. Mentioned in the Ecclesiastical Survey of the Philippine Islands in 1637–1638.

Parcado.—A large Philippine outrigger with two masts for sails. Roofed with trestle work of bamboo and buri or nipa leaves. Common in Tayabas, Mindoro, and Batangas. (Plate 10, fig. 1.)

Pilan.[54]—A small boat used in 1638–1640, equipped for the transportation of fighting men and ammunition. In 1609–1700 the pilans were the vessels that captured the *joanga,* a flat boat, manned by Moros from Mintun (*Mutul*) which carried Father Lopez to Simuay, Cotabato. Mentioned in Events in Filipinas.

Pinaza (*pinnace*).[55]—A light sailing vessel, often schooner-rigged, sometimes also using oars, used largely as a tender for warship or other large vessels. Mentioned in a letter of Francisco de Ortega to the Viceroy in 1580–1605.

Piragua (*pirogue*).[56]—A very swift and light dugout canoe used by the natives in Mindanao. Mentioned in Events in Filipinas in 1721–1739.

Pitsuya.—A large vessel made of planks provided with narrow bamboo rafts with oars and *tiquines* (long bamboo poles) on each side. Used in navigable rivers for loading merchandise.

Pontin.[57]—A stoutly built coasting vessel of European model, from 80 to 150 tons, with two long mat sails, like a Chinese junk. Used in coastwise trade in 1801–1840. Mentioned in a letter from Father Quirico More to the Father Superior of the Mission, 1885. Common in La Union Province.

Prao (*parao, prahu, proe, prow—Malay*).[58]—A large, swift, flat boat with two masts and lateen sails. Used for carrying freight and employed in the rivers and bays. It resembled the *fusta.* Its sails are made of palm mats. It is of from 20 to 30 tons burden, and propelled by both sails and oars. Draws but little water and is a fast sailer, well suited to navigation through dangerous seas. The vessels are armed with muskets, blunderbusses, krises, hatchets, and spears, and at times two large mounted guns. Mentioned in Resumé of Contemporaneous Documents, 1559–1568.

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[53] Op. cit. 28 (1905) 212.

[54] Op. cit. 29 (1905) 144.

[55] Op. cit. 34 (1906) 271.

[56] Op. cit. 29 (1905) 171.

[57] Op. cit. 43 (1906) 194.

[58] Op. cit. 2 (1903) 144.

Salisipan.—A very light and fast craft used by the Moros on their piratical expedition. Common in southern waters.

Sapit.[59]—A large cargo boat of the Mohammedan Moros made by the Samal people of the Tawitawi Islands. Built up from a keel, the cutting and shaping done by hand. Typically Moro. (Plate 11, fig. 2.)

Saraboa (*salambao*).[60]—A fishing raft of reeds or bamboo on which is erected an apparatus not unlike the mast and yard of a square-rigged ship. The nets used in the bay or river are suspended by the four corners from hoops attached to a crane by which they are lowered into the water. This type of fishing raft is used in the islands up to the present time (Plate 11, fig. 1).

Sloop.[61]—A vessel having one mast and fore-and-aft rig, consisting of a boom-and-gaff mainsail, a jib or jibs, often a stay sail, and usually a gaff topsail. The typical sloop has a fixed bowsprit, topmast, and standing rigging; those of the cutter type may be readily shifted. This type of vessel appeared in the Philippines in 1880.

Soma.[62]—A large vessel from Great China laden with merchandise. These boats came in groups to Manila with the monsoon and settled weather which generally came with the advent of the New Moon in March. Mentioned in Morga's Sucesos, 1609.

Steamboat (*steamship*).[63]—A vessel propelled by steam power generally used in navigable rivers and seas as coasting craft. Used at present in the islands for transporting merchandise and passengers. (Plate 10, fig. 2.)

Taculi.[64]—A type of transportation vessel used in Cagayan River for loading merchandise. Propelled by oars. Similar to the virey or barangay.

Talisay.[65]—A fisherman's boat made of talisay (*Terminalia catappa*). Mentioned in Events in Manila in 1662–1663.

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[59] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 16.

[60] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **53** (1906) 149.

[61] Op. cit. **39** (1906) 31.

[62] Op. cit. **14** (1904) 177.

[63] Webster New International Dictionary of the English Language (1938) 2465.

[64] Census of the Philippine Islands: 1903 (1905) 588.

[65] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. **34** (1906) 223.

Tapaque.[66]—A large, light, roomy vessel for conveyance of merchandise. Can be dragged on shore at night; navigated without going into the open sea or leaving the shore. Some of these tapaques were so long that they could carry 100 rowers on one side and 30 soldiers above to fight. Mentioned by Antonio de Morga in his Sucesos de las Islas Filipinas in 1609.

Taratana.[67]—One of the armed vessels sent against the Moro pirates during 1721–1734 under the command of Antonio Roxas who sailed from Manila on July 10, 1721, to attack Jolo.

Tataya.—A carvel-built vessel provided with three oars on each side of the hull. Each oar is tied with rope to a wooden peg. It is held together by rattan lashing. No iron nail is used. Usually painted with charcoal and lime. Used on sea. Common in Batanes Islands at present.

Tugboat (*towboat*).—A strongly built, powerful steam vessel, whose engineer, bunkers, and stokehole occupy practically all the room except that needed for the crew. Common in ports of call like Manila, Iloilo, Cebu, and Tacloban.

Tunguli (*timghuly*).[68]—A small boat usually with the squadrons of *praos.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo in 1519–1522.

Urca.[69]—Built like a pink—that is, with a very narrow stern—and sloop-rigged. Mounted with 24 pieces of artillery. Mentioned in a letter of Juan de Silva to Philip III in 1609–1616.

Vilox.[70]—A boat made of wood and bamboo. A common means of transportation in Iloilo for loading merchandise on sea and river.

Vinta.[71]—A general utility boat of the Moros which is built in the rough at Basilan Island and brought south for the ornamental carving of its bows and sides. Equipped with bamboo outriggers and propelled by paddles or by a lateen sail of muslin attached to a tripod mast of bamboo which is stepped well forward. It is usually so light that a foot and a half of water depth suffices. It can easily go up the streams and brooks. It is still in use at present. Common in Mindanao and Sulu. (Plate 12, fig. 2.)

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[66] Op. cit. 14 (1904) 83.

[67] Op. cit. 46 (1906) 223.

[68] Op. cit. 33 (1906) 221.

[69] Op. cit. 17 (1904) 145.

[70] Census of the Philippine Islands: 1903 (1905) 589.

[71] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 41 (1906) 305.

Virey (*birey, viray*).[72]—An unsteady vessel navigated only near the shore. Mentioned in Sande's Relation in 1576. Common in Cagayan, Ilocos Norte, Ilocos Sur, and La Union Provinces.

Virocco (*biroco*).[73]—A light vessel made in Catanduanes and sold in a curious manner. A large vessel, undecked, without iron nail or any fastening is first built. Another vessel is made to fit its hull. Within that they put a second, a third, and so on. Thus, a large biroco often contains 10 or 12 vessels, called *biroco, virey, barangay,* and *binitan.* Mentioned in Morga's Sucesos de las Islas Filipinas (1609).

Yacht.—A vessel larger than a rowboat, used either for private trips, or as a vessel of state to convey distinguished persons from one place to another on official trips. The name also refers to swift small racing sailboats.

Zalea (*xalea*).[74]—A Spanish flagship used in expedition to Sulu in 1638–1640. On her return voyage it collided with a champan from Manila which carried Father Marcelo Mastril. The shock was so severe that the flagship sprung a leak and went down. One Spaniard and one Sangley were drowned. Mentioned in Events in Filipinas (1721–1739).

Zebeck (*xebec*).[75]—A Mediterranean vessel with long overhanging bow and stern, usually three-masted, lateen-rigged, but often carrying square sails on the foremast. Formerly used as corsairs. Mentioned in Vice Admiral S. Cornish's letter to Mr. Cleveland in 1759–1765.

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[72] Op. cit. 4 (1903) 26.

[73] Op. cit. 14 (1904) 107.

[74] Op. cit. 29 (1904) 23.

[75] Op. cit. 49 (1907) 44.

ILLUSTRATIONS

PLATE 1

FIG. 1. The *balsa* (raft) a makeshift means of conveyance across rivers.
2. The *balsa* full of passengers and vehicles crossing Laoag River.

PLATE 2

FIG. 1. Typical dug-out boat known as *banca, canoe,* or *lunday.*
2. Bancas roofed with trestlework of bamboo and buri or nipa leaves.

PLATE 3

FIG. 1. A Philippine canoe with outriggers.
2. An outrigger canoe with sail.

PLATE 4

FIG. 1. The *barangay,* the most primitive and the most characteristic boat in the islands.
2. A fleet of casco on the Pasig River for loading merchandise.

PLATE 5

FIG. 1. Another type of casco with masts for sails. (After Palgrave.)
2. *Chalana* (scow) full of passengers and motor vehicles.

PLATE 6

FIG. 1. *Champan,* a Chinese vessel used by the Chinese for trading in the Philippines. (After Webster.)
2. An ancient type of passage boat (ferry boat) for conveying passengers across a river. (After La Gironiere.)

PLATE 7

FIG. 1. *Falua,* a fast, three-masted, lateen-rigged vessel found in the islands some time in 1636–1637. (After Webster.)
2. Galleon, a 15th century sailing vessel used for war or for commerce by the Spaniards in the Manila-Acapulco Trade. (After Webster.)

PLATE 8

FIG. 1. *Garays* of the Sulu Moro pirates that spread terror on the seas. (After Orosa.)
2. *Goleta* moored at Iloilo River. (After Laureano.)

PLATE 9

FIG. 1. A Bajao houseboat in the Sulu Sea. (After Orosa.)
2. Junk, a characteristic Chinese vessel formerly found in the islands. (After Webster.)

PLATE 10

FIG. 1. *Parcado,* a large Philippine outrigger with masts and sails.
2. Inter-island vessel used at present in navigable rivers and seas as coasting craft.

PLATE 11

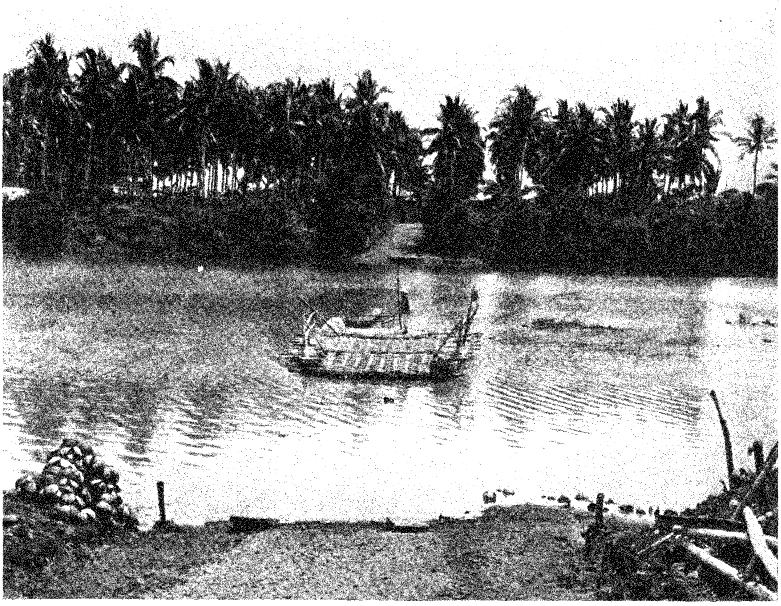
FIG. 1. *Saraboa* (salambao), or fishing raft. (After La Gironiere.)
2. *Sapit,* a large cargo boat of the Samal Moros. (After Taylor.)

PLATE 12

FIG. 1. Canadian Pacific Liner (Empress of Asia), at Pier 7.
2. *Vinta,* a general utility boat of the Samal Moros. (After Taylor.)

PLATE 13

FIG. 1. Ship building at Dagupan, Pangasinan Province.
2. A fleet of Moro Vintas with buntings on festive occasion.



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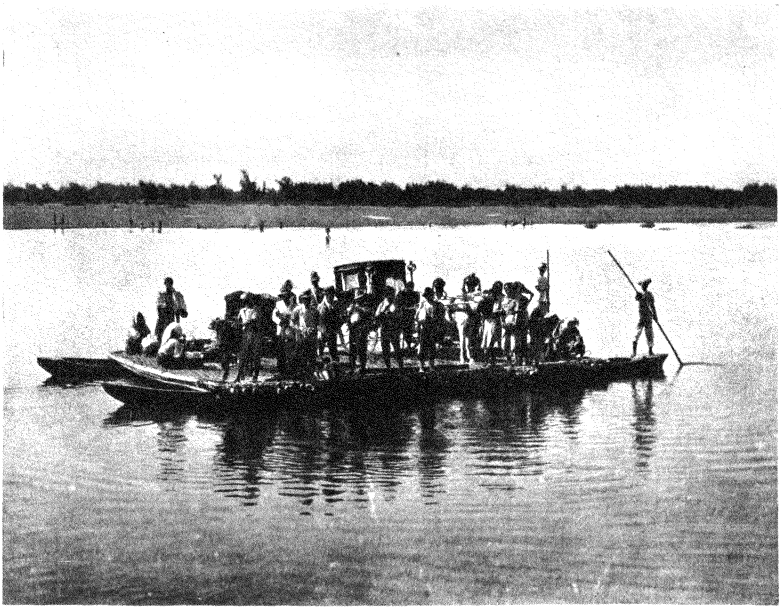

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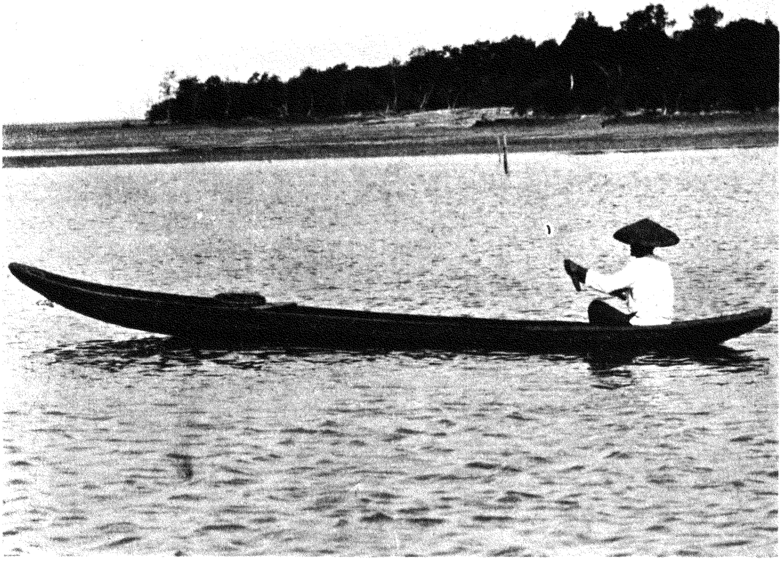

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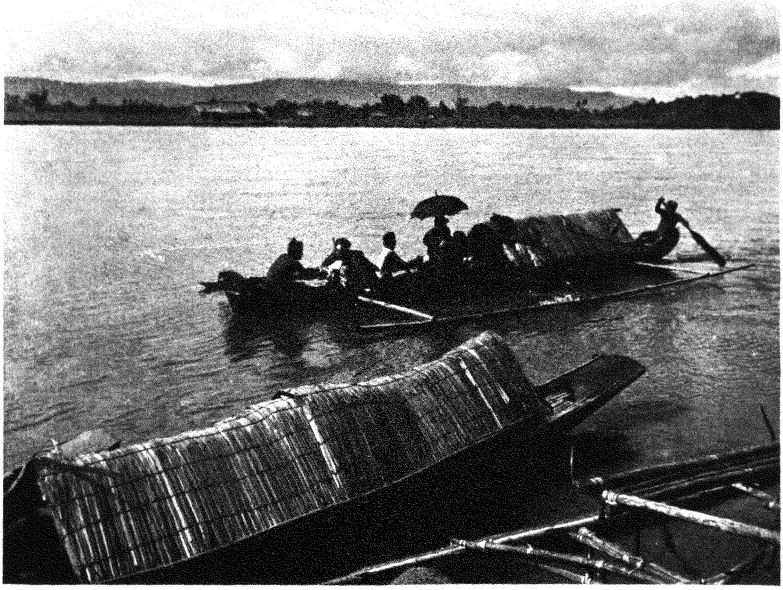

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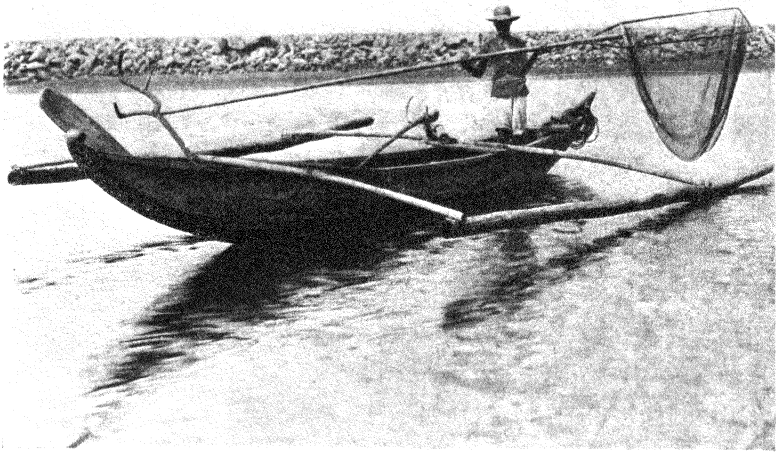

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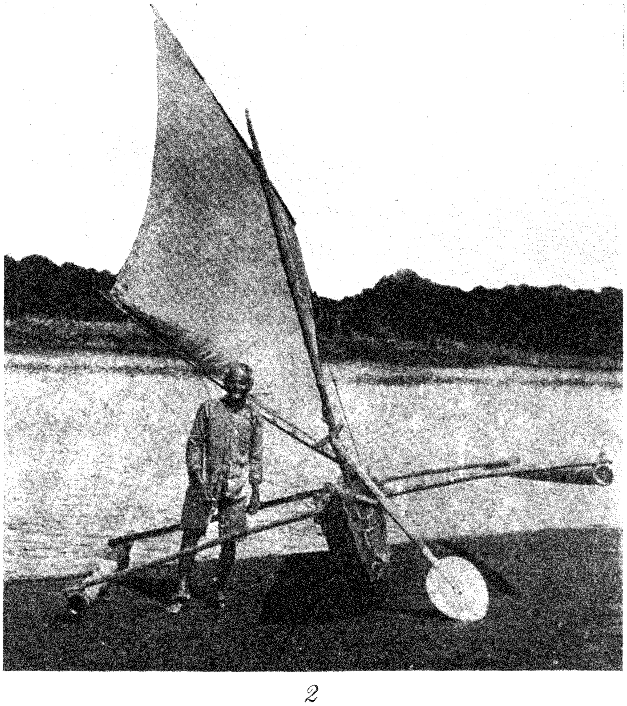

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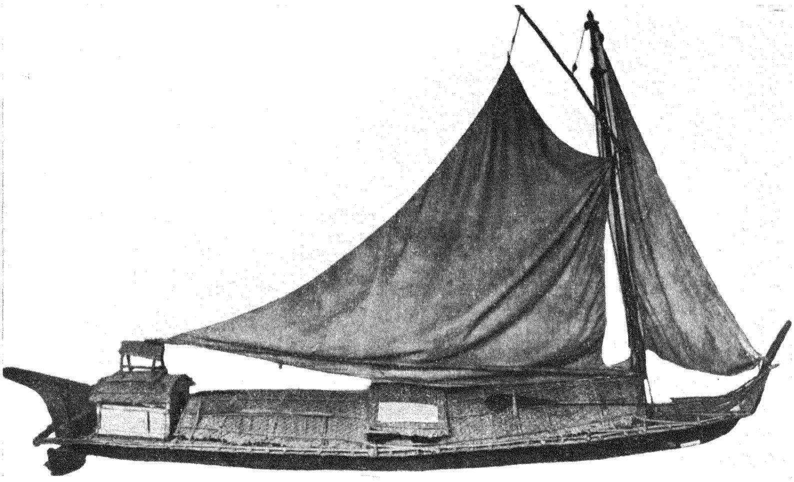

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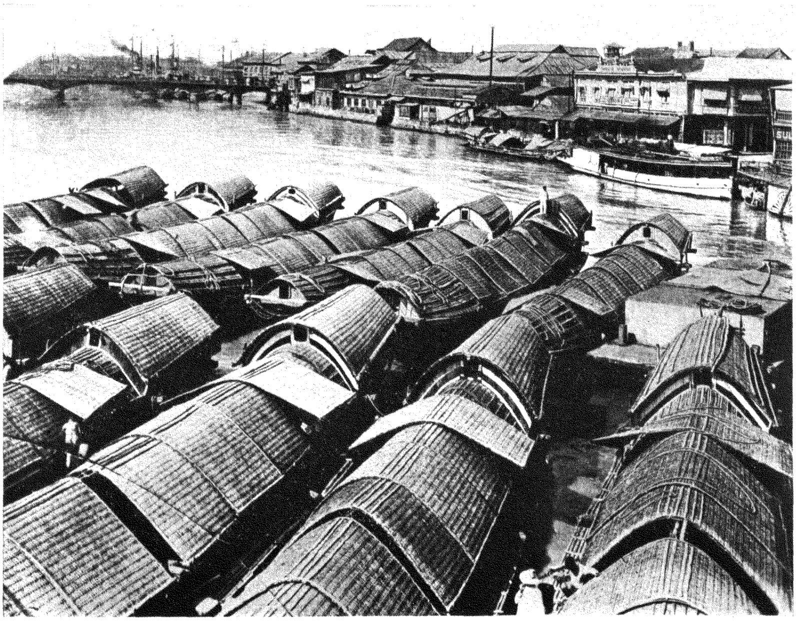

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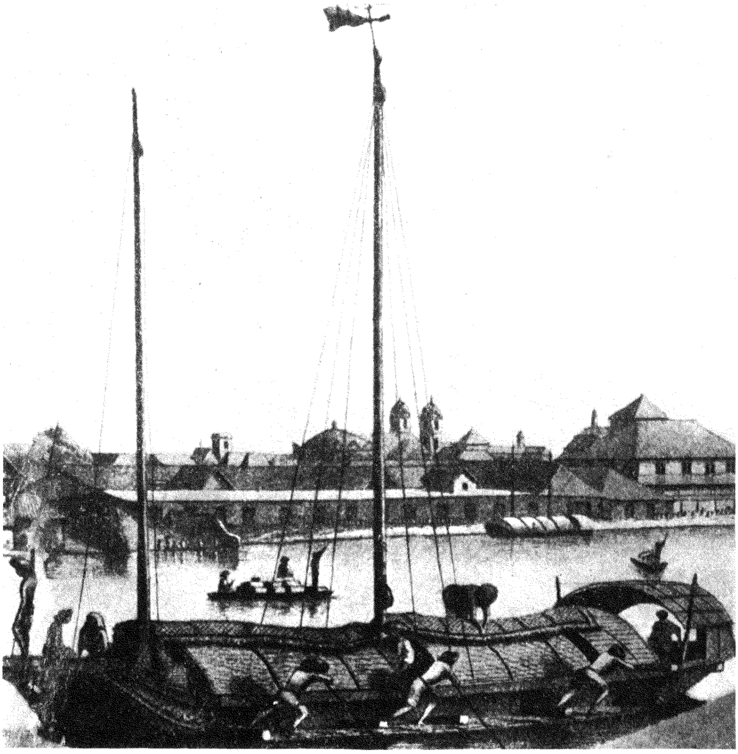

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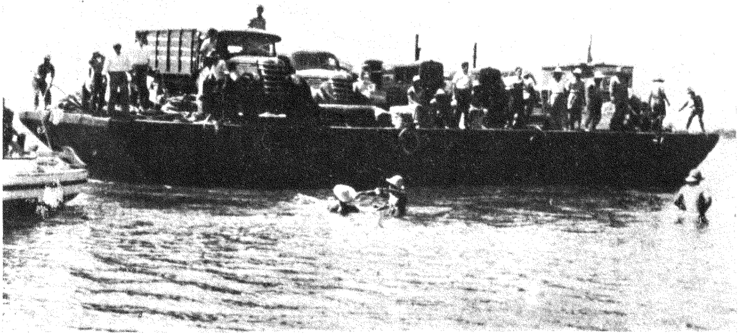

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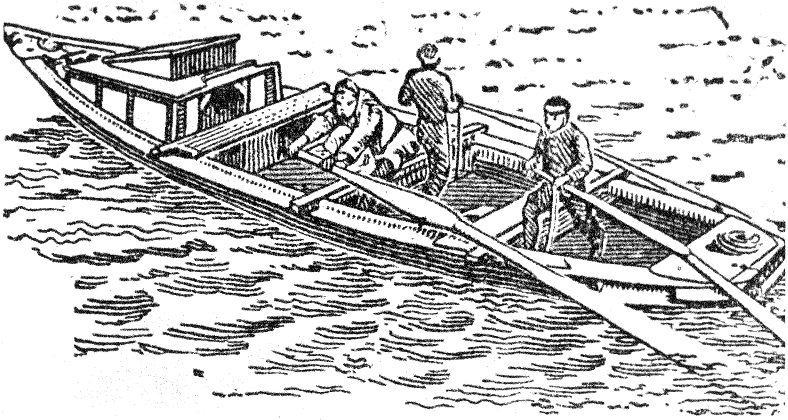

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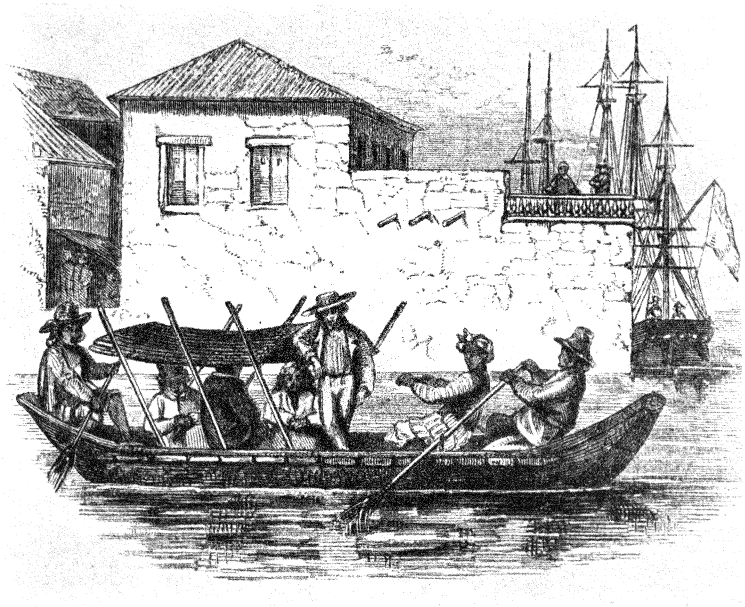

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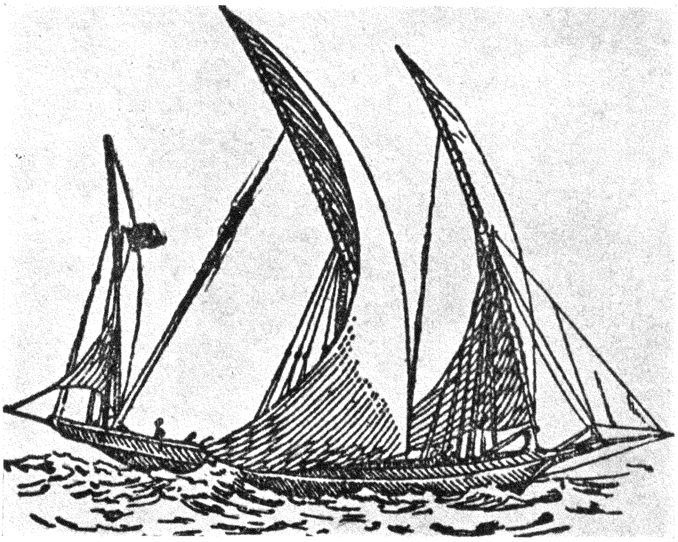

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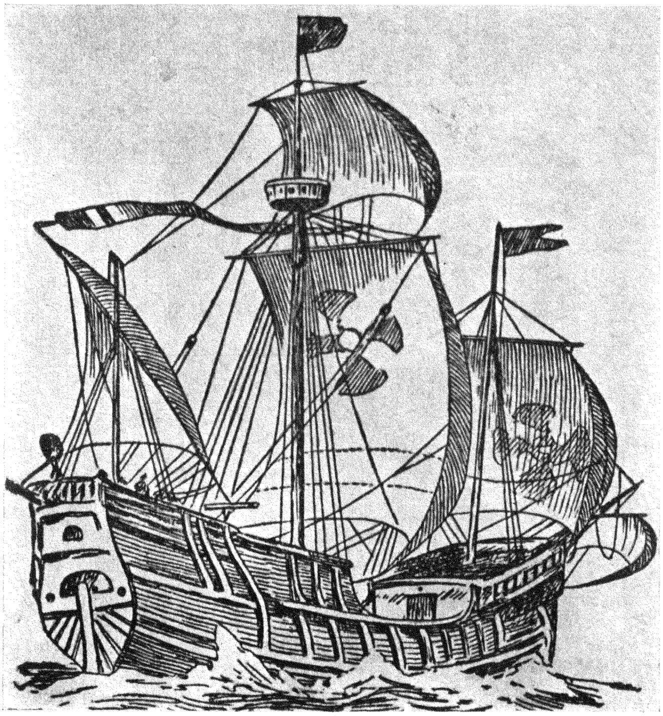

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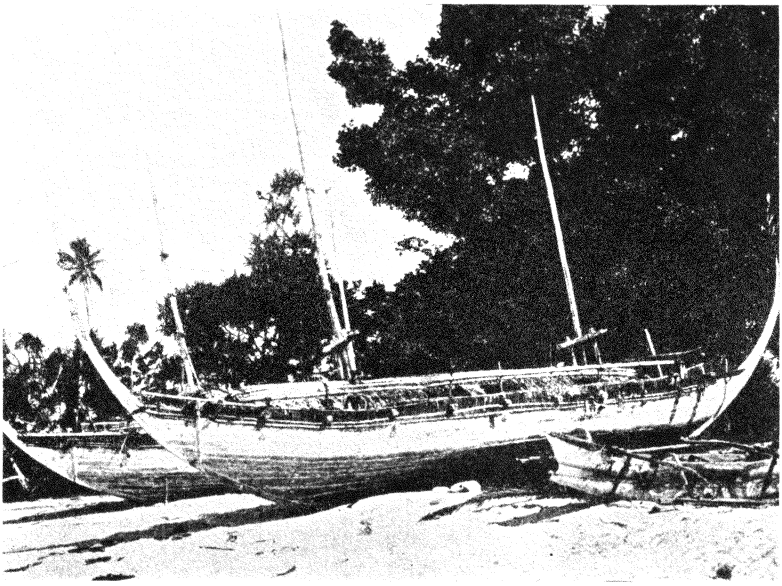

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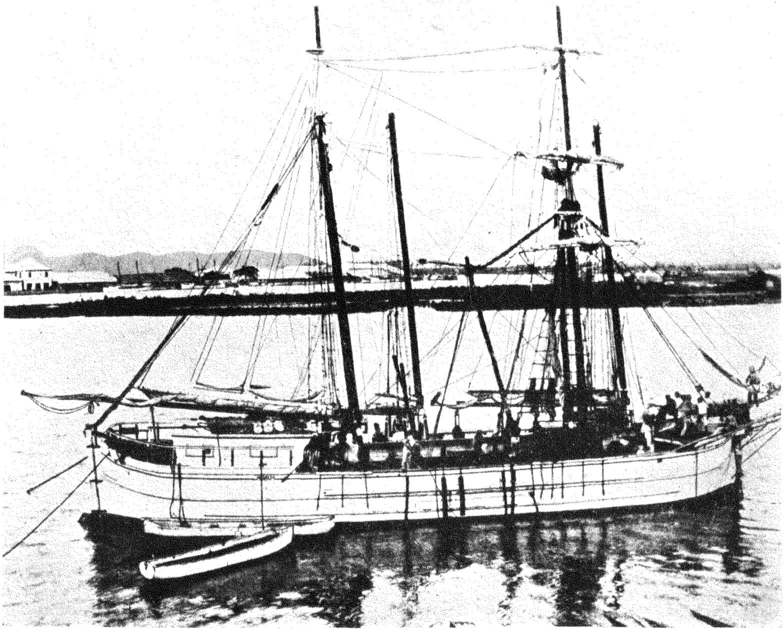

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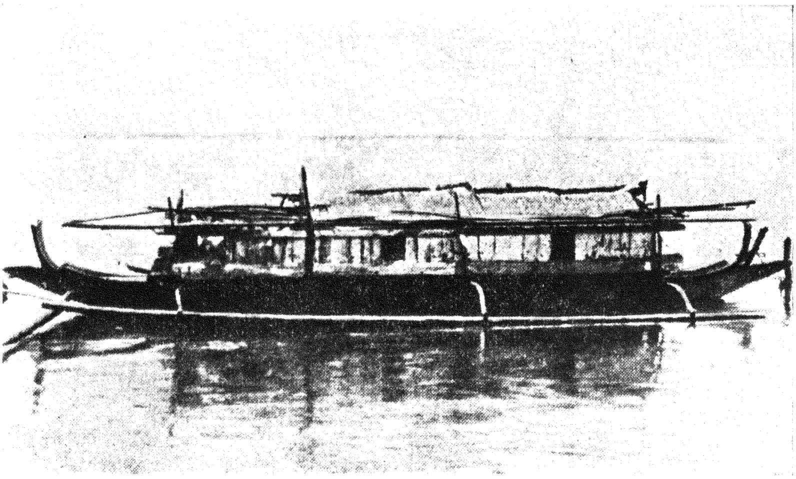

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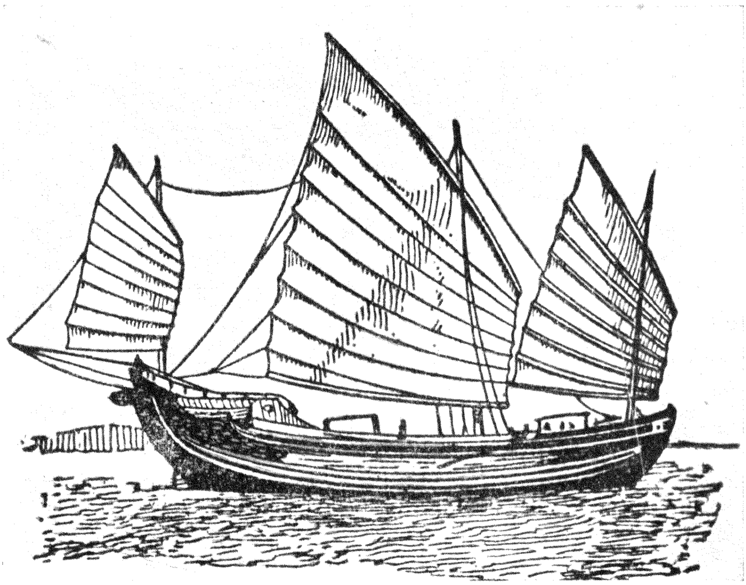

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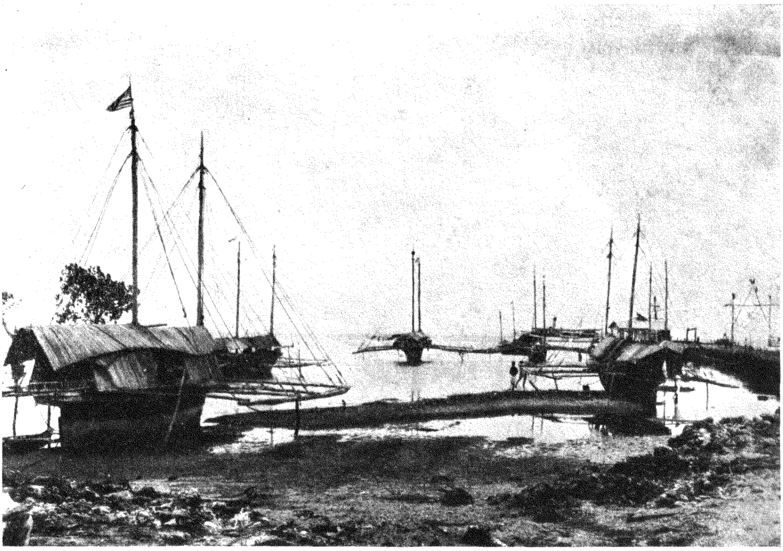

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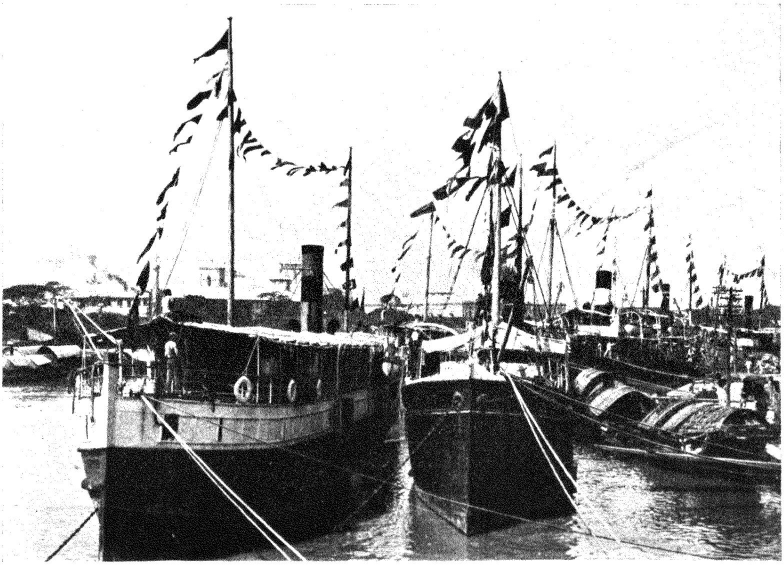

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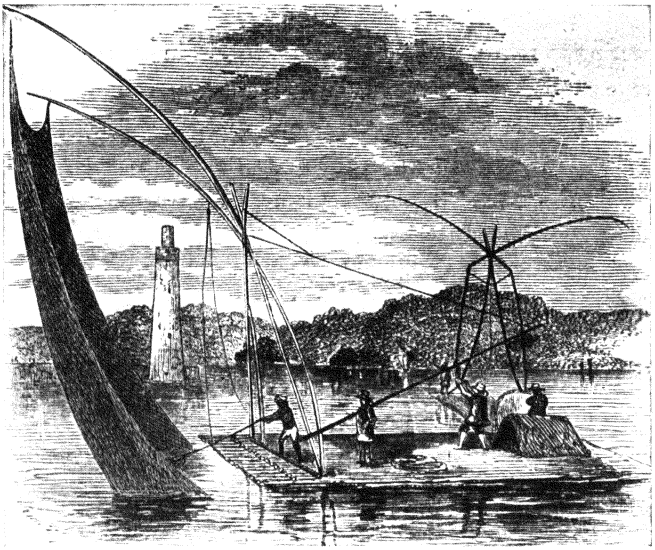

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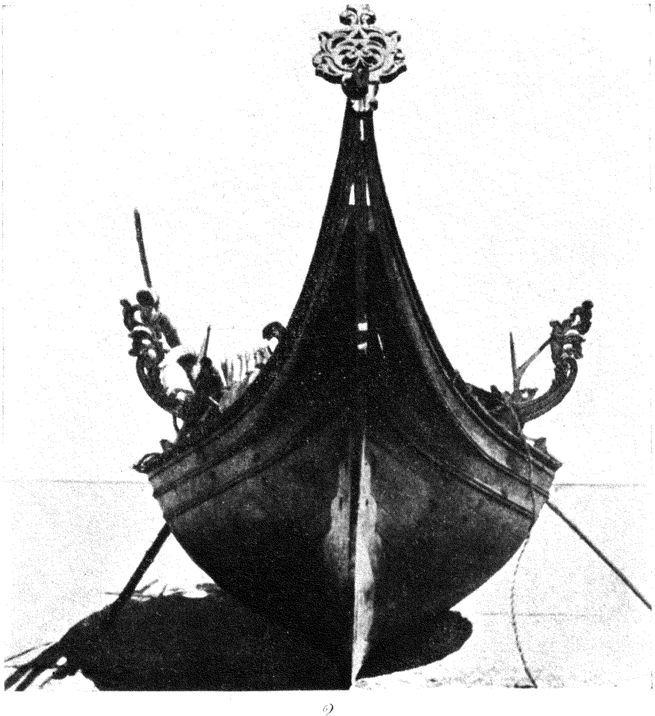

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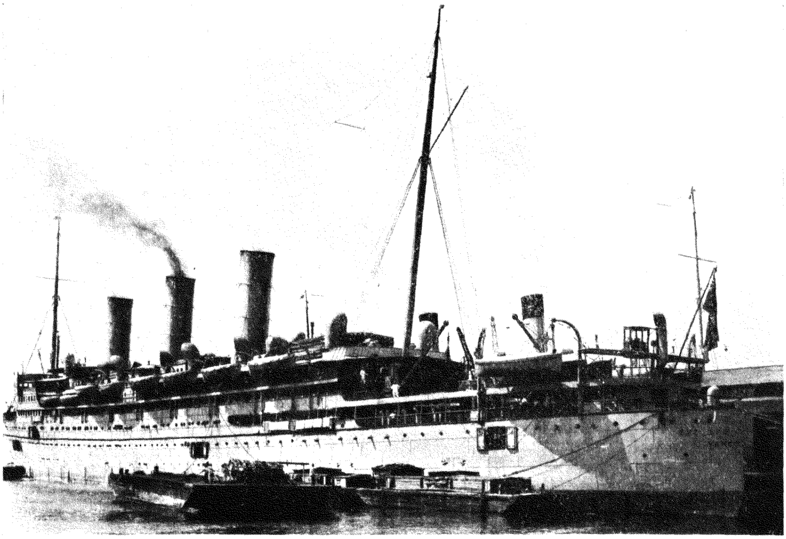

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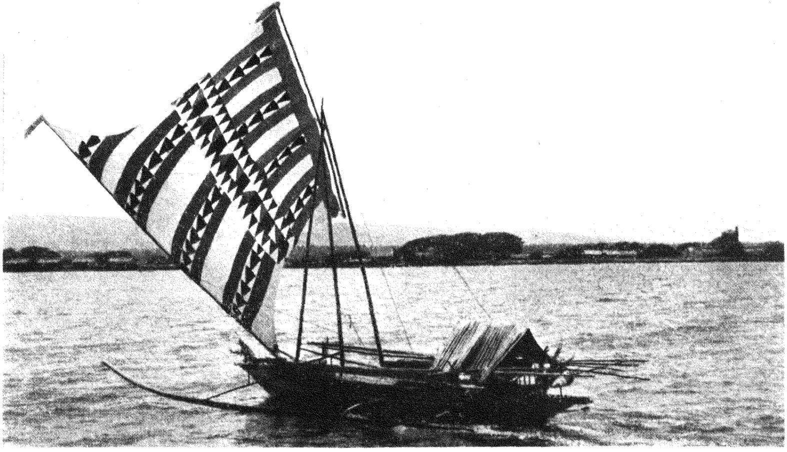

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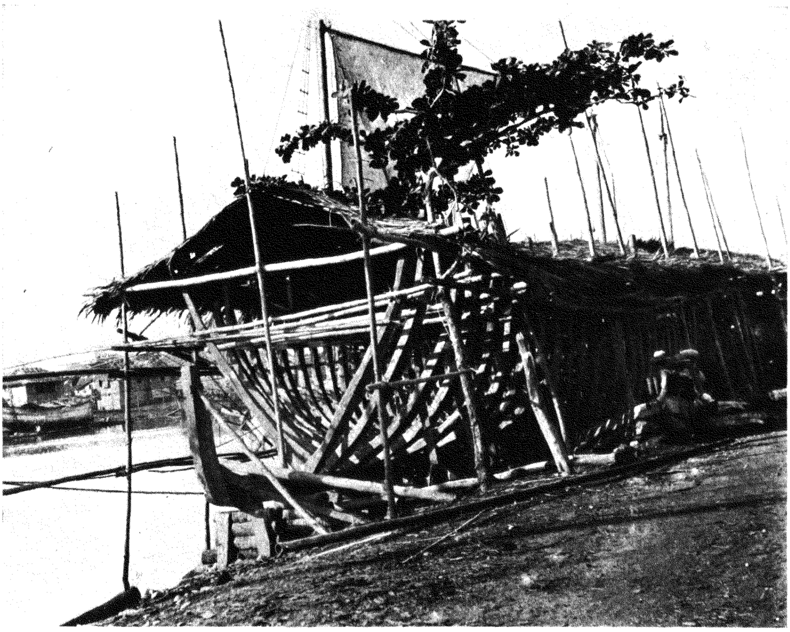

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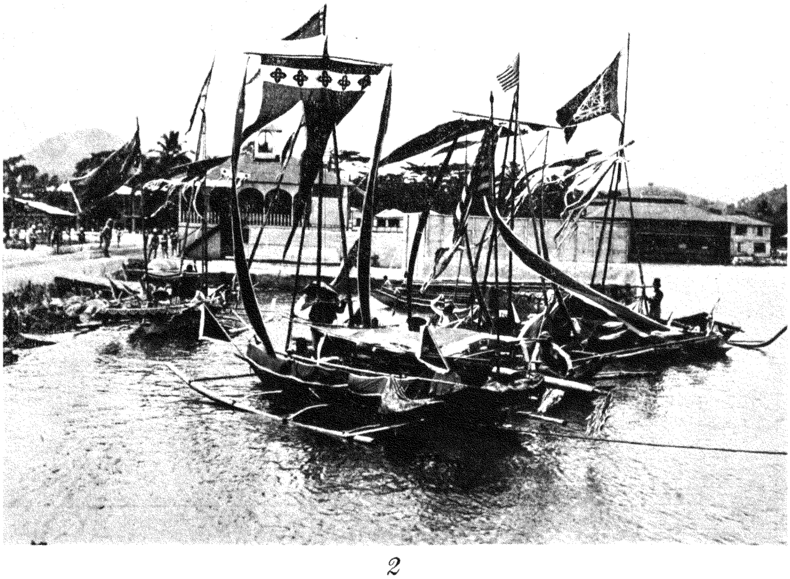

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PLATE 13.

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LABIDOCERA GLAUCA SP. NOV., A BLUE COPEPOD OF PUERTO GALERA BAY, MINDORO [1]

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Of the Division of Fisheries
Department of Agriculture and Commerce, Manila

ONE PLATE AND SIX TEXT FIGURES

The writer is under obligation to Dr. Felix V. Santos, formerly of the Department of Zoology, University of the Philippines, for supervision of the work on which this report is based, and to Dr. Hilario A. Roxas, head of the same Department, for certain helpful suggestions in the research.

LABIDOCERA GLAUCA sp. nov. Plate 1.

Male.—Body laterally compressed, average length 3.2 mm; head evenly rounded, without side hooks but with a forked rostrum ending in strong rostral prongs. Length of head about ½ that of cephalothorax. Dorsal eye lenses cuticular and larger than in the female. Diameter of median ventral eye greater than that of dorsal eye. Cephalothorax divided into 7 segments. First two thoracic segments practically of equal size, but longer than any of the last four thoracic segments (Plate 1, fig. 1). Last thoracic segment symmetrical, fused with preceding segment and provided on each side with a lateral spine pointing posteriorly (Plate 1, fig. 2). Abdomen as long as head (Plate 1, fig. 1). Four abdominal segments bilaterally symmetrical. Furca also bilaterally symmetrical. Antenna asymmetrical, first left antenna composed of 23 segments reaching almost to base of furca. Many bristles covered with hairs present on outer side of antenna. Bristles decreasing toward terminal region. Hairs on inner side extending from about 1st segment to 13th. Segments of right antenna (grasping organ) fused to consist of 16 visible segments. Several fairly long bristles covered with hairs along inner side, bristles absent on outer side; sutured fold covering 11th and 12th visible seg-

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[1] A portion of the thesis submitted to the Faculty of the University of the Philippines in partial fulfillment of the requirements for the degree of Master of Science in 1935.

ments on inner side; another sutured area covering about $\frac{3}{4}$ of 13th portion of two segments preceding terminal segment, generally provided with 5 sets of terminal spines (Plate 1, fig. 4). Thick left swimming leg (often referred to as swimming foot) 4-jointed, without endopodite. Terminal segment provided with 4 bristles at end, with numerous, thickly set hairs on inner surface. Terminal spine on second distal segment (Plate 1, fig. 10). Head segment of right 5th leg with proximal internally directed pronglike extension, terminal segment slender, recurved, terminating in a pronglike portion with one median and one terminal spine (Plate 1, fig. 11).

Female.—Average length of female approximately 3.5 mm (Plate 1, fig. 12). Female differs from male in: (*a*) Eyes generally smaller and never as close together as sometimes found in the male; last thoracic segment produced on either side to a rounded lobe and provided with a spine placed asymmetrically on side of segment (Plate 1, fig. 15). (*b*) Abdomen consisting of 2 segments, genital segment much larger than anal and provided with a lateral lobe on left side where genital opening is situated. (*c*) Anal segment twice as wide as long; furca symmetrical (Plate 1, fig. 14). (*d*) Antennæ similar to the left antenna of the male and reaching almost to the posterior border of the genital segment (Plate 1, fig. 15). (*e*) Sides provided each with 3 lateral, 1 terminal, and 1 median spine. A very small 4th lateral spine proximal to the terminal spine present in some specimens on left side, in others on right.

Light blue in life; colorless in 80 per cent alcohol.

Labidocera glauca, commonly known as the blue copepod, differs from Wheeler's(30) description of the genus *Labidocera* in two respects: (1) Wheeler describes this genus as possessing 5 segments in the cephalothorax, while the specimen under consideration has 7 segments; (2) the abdomen of the male *Labidocera* as described by Wheeler possesses 5 segments, while the Puerto Galera specimen has only 4 segments. The latter is in conformity with Lubbock's description.(19)

ECOLOGY

During April and May of 1933 and 1934 ecological studies were conducted at the Marine Biological Station of the University of the Philippines, Puerto Galera, Mindoro. The major problem involved was the determination of the diurnal vertical migrations of plankton, particularly *L. glauca,* to the surface of the water. Special emphasis also was placed on the sex ratio of *L. glauca.*

A path to be followed on the collecting trips was laid out in a cove at Puerto Galera Bay. A definite point suitable for the lowering of the plankton net into the water was chosen at about 5 meters from the shore at the landing place. The turning point was a spot approximately 300 meters from the landing. The path was retraced on the return trip and the net raised at the place where it was lowered. A No. 17 plankton net was employed. The data obtained on these trips are given in Tables 1 to 5.

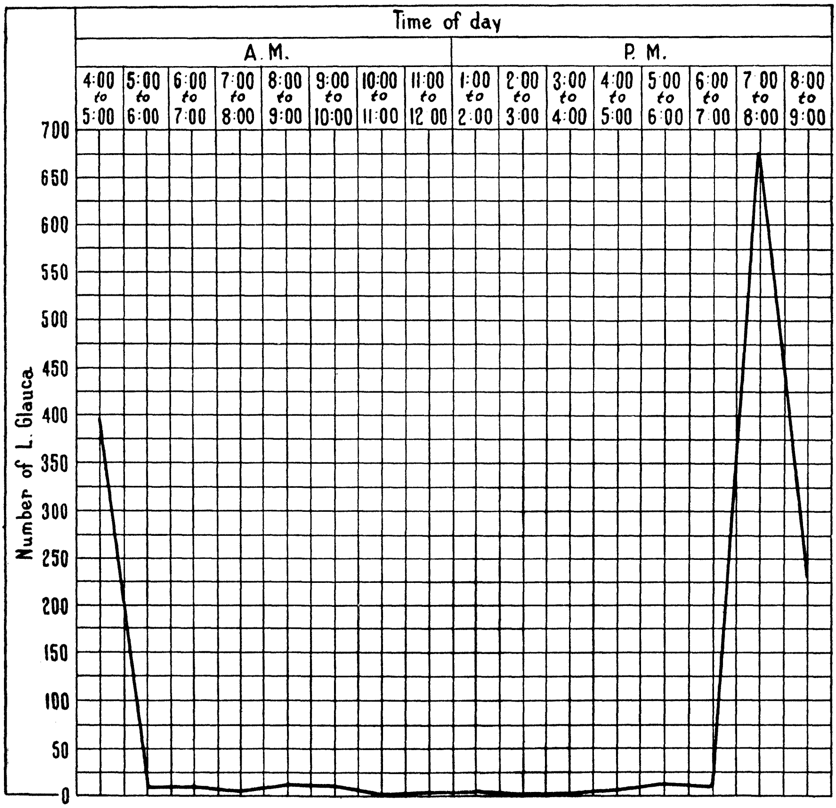

FIG. 1. Average numbber of *L. glauca* according to time of day. Based on Table 1.

L. glauca come to the surface of the water after 4 A. M. and remain until about 5 A. M., after which they soon disappear and appear again after 7 P. M. (text figs. 1 and 2). These migrations to the surface during darkness, and the apparent

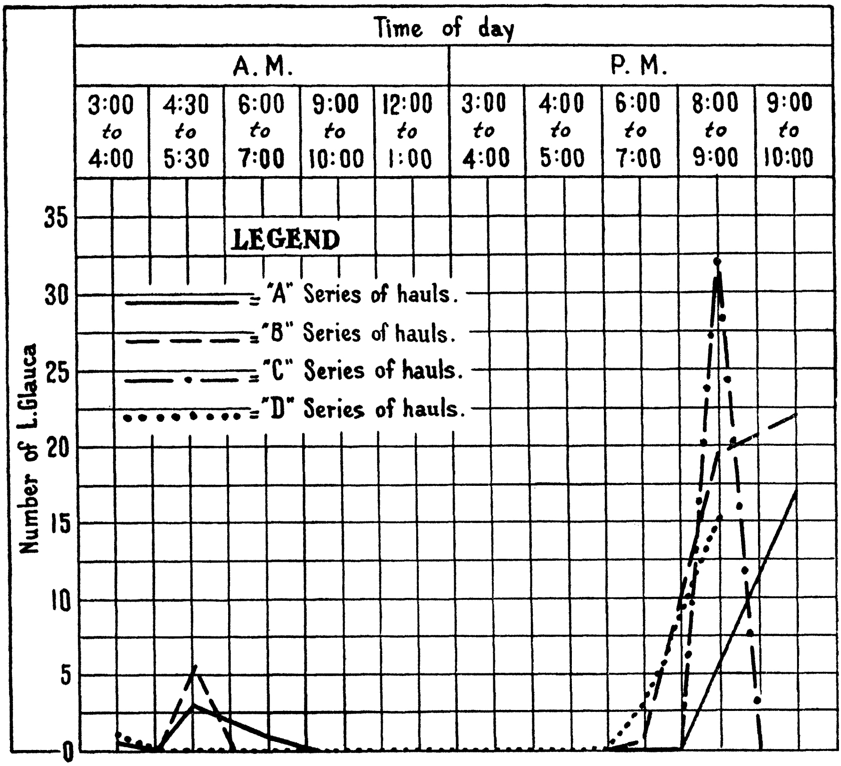

FIG. 2. Average number of *L. glauca* according to time of day. Based on Tables 2 to 5.

TABLE 1.—*Number of L. glauca and amount of plankton according to time of day (1933).*

Haul No.	Time.	Date.	Water temperature.	Number of *L. glauca* per haul.			Plankton.
				Total.	Male.	Female.	
	A. M.						cc.
1	4:25-4:35	May 6	27.3	393	206	187	9.0
2	5:45- 6:00	May 2	26.6	11	10	1	16.5
3	6:10- 6:25	April 19	27.2	10	3	7	10.5
4	7:00- 7:15	May 4	27.2	5	2	3	14.5
5	8:00- 8:15	April 5	26.5	[a] 16	------	------	10.5
6	9:15- 9:32	April 6	26.4	[a] 9	------	------	6.5
7	10:00-10:15	April 18	27.2	[a] 0	------	------	6.5
8	11:08-11:20	April 5	25.1	[a] 2	------	------	5.0
	P. M.						
9	1:07- 1:20	April 6	27.0	[a] 3	------	------	5.0
10	2:10- 2:25	April 8	27.2	[a] 0	------	------	5.5
11	3:06- 3:20	April 4	26.8	0	------	------	9.0
12	4:05- 4:22	April 6	27.0	5	2	3	9.0
13	5:03- 5:15	April 5	26.5	11	------	------	6.0
14	6:03- 6:15	April 6	27.4	10	2	8	6.0
15	7:08- 7:21	May 4	------	675	378	297	42.0
16	8:10- 8:25	April 21	27.8	228	143	85	21.0

[a] Sex not recorded.

TABLE 2.—*Record of hauls made with the tide receding, series A.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female.	
	A. M.		*feet.*			°*C.*						*cc.*
1	4:30– 4:47	May 4	1.0	transition	calm	26.5	([a])	sunrise	3	2	1	2.1
2	6:46– 6:57	April 21	1.4	weak daylight	do	26.0	8.4	misty	1	0	1	0.0
3	9:08– 9:20	April 25	3.0	medium day light	slight waves	28.0	([a])	cloudy	0			[b]1.0
	P. M.											
4	12:20–12:29	April 30	3.3	intense daylight	do	29.5	8.4	blue sky	0			0.5
5	3:10– 3:21	April 21	3.9	medium daylight	wind on calm	27.3	8.4	cloudy	([a])			17.4
6	4:08– 4:18	April 20	3.6	weak daylight	calm	27.3	8.4	overcast	([a])			[b]50.0
7	6:21– 6:32	April 21	2.4	transition	slight waves	27.0	8.4	sunset	([a])			[b]21.2
8	6:23– 6:35	May 4	1.9	do	do	27.5	([a])	do	([a])			7.0
9	8:57– 9:11	do	0.7	after sunset	do	27.0	([a])	dark	19	13	6	8.0
10	8:04– 8:08	April 20	0.3	do	wind on calm	26.4	([a])	half moon	10	5	5	34.0
11	8:09– 8:19	May 8	3.0	do	calm	28.5	([a])	dark	6	6	0	3.0
								Total	39	26	13	163.2

[a] No determination.

[b] Much algæ.

TABLE 3.—*Record of hauls made with the tide receding, series B.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul. Total.	Male.	Female.	Plankton.
	A. M.		*feet.*			°*C.*						*cc.*
1	4:56– 5:11	May 4	1.0	transition	calm	26.5	([a])	sunrise	8	5	3	4.5
2	9:23– 9:41	April 25	3.0	medium daylight	slight waves	28.0	([a])	cloudy	0	0	0	1.0
	P. M.											
3	12:33–12:43	April 30	3.3	intense daylight	do	29.5	8.4	blue sky	0	0	0	0.4
4	3:26– 3:38	April 21	3.9	medium daylight	wind on calm	27.3	8.4	cloudy	0	0	0	[b] 13.6
5	4:24– 4:34	April 20	3.6	weak daylight	calm	27.3	8.4	overcast		0	0	[b] 50.5
6	6:37– 6:47	April 21	2.4	transition	slight waves	27.0	([a])	sunset	0	0	0	23.5
7	6:38– 6:51	May 4	1.9	do	do	27.5	([a])	do	2	1	1	5.0
8	8:13– 9:23	do	0.6	after sunset	do	27.0	([a])	dark	22	15	7	6.5
9	8:18– 8:26	April 20	0.3	do	wind on calm	26.4	([a])	half moon	30	21	9	43.0
10	8:23– 8:34	May 8	3.0	do	calm	28.5	([a])	dark	8	5	3	3.5
								Total	70	47	23	148.5

[a] No determination.

[b] Much algæ.

TABLE 4.—*Record of hauls made with the tide rising, series C.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female.	
	A. M.		*feet.*			°*C.*						*cc.*
1	4:56- 5:08	April 24	1.0	transition	calm	27.5	8.4	sunrise	0	-----	-----	2.0
2	6:07- 6:18	April 27	1.8	weak daylight	slight waves	27.5	8.4	blue sky	0	-----	-----	0.8
3	9:06- 9:16	April 20	1.6	medium daylight	calm	27.4	8.4	cloudy	0	-----	-----	[a] 50.0
	P. M.											
4	12:08-12:18	April 23	1.9	intense daylight	slight waves	28.5	8.4	blue sky	0	-----	-----	5.7
5	3:05- 3:14	April 23	2.5	medium daylight	do	28.7	8.4	do	0	-----	-----	5.0
6	4:05- 4:16	April 24	2.9	weak daylight	do	29.0	-----	do	0	-----	-----	10.0
7	6:30- 6:47	April 26	1.6	transition	calm	29.0	8.4	sunset	0	-----	-----	2.0
8	8:49- 9:00	April 30	3.0	after sunset	slight waves	28.0	8.4	full moon	31	20	11	4.0
9	8:30- 8:42	April 26	1.0	do	do	28.5	8.4	half moon	33	16	17	2.5
	A. M.											
10	3:33- 3:47	May 8	1.2	do	calm	28.2	8.4	full moon	1	0	1	1.0
11	8:20- 3:33	May 10	1.2	do	do	28.0	8.4	starlight	1	0	1	0.3
								Total	66	36	30	83.8

[a] Much algæ.

TABLE 5.—*Record of hauls made with the tide rising, series D.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female	
	A. M.		*feet.*			*oC.*						*cc.*
1	5:12– 5:25	April 24	1.0	transition	calm	27.3	8.4	sunrise	0			2.0
2	6:22– 6:34	April 27	1.8	weak daylight	slight waves	27.5	8.4	blue sky	0			0.7
3	9:20– 9:34	April 20	1.6	medium daylight	calm	26.4	8.4	cloudy	0			[a]39.0
	P. M.											
4	12:22–12:30	April 23	1.9	intense light	slight waves	28.5	8.4	blue sky	0			6.0
5	3:18– 3:27	do	2.5	medium daylight	do	28.7	8.4	blue sky	0			5.3
6	4:20– 4:30	April 24	2.9	weak daylight	do	29.0	8.4	do	0			4.5
7	6:51– 7:01	April 26	1.6	transition	calm	29.0	8.4	sunset	3	1	2	3.0
8	9:05– 9:17	April 30	3.0	after sunset	slight waves	28.0	8.4	full moon	6	5	1	2.5
9	8:44– 8:57	April 26	1.0	do	do	28.5	8.4	half moon	15	8	7	3.0
	A. M.											
10	3:52– 4:09	May 8	1.2	do	calm	28.2	8.4	full moon	1	0	1	0.5
11	3:40– 3:52	May 10	1.2	do	do	28.0	8.4	starlight	0			0.1
								Total	25	14	11	84.6

[a] Much algæ.

absence of this copepod during daylight, tend to prove that *L. glauca* are negatively phototropic. However, the fact that very few were found on the surface between 2:30 and 4 A. M. indicates that other factors are involved. The factors of temperature, pH, and condition of the surface of the water, height and direction of the tide, and condition of the sky were all found to have insignificant bearing on the problem at hand. The writer's contention is then that *L. glauca* is negatively phototropic, since very few individuals are ever found on the surface of the water during daylight, although they do not remain on the surface during the entire period of darkness. They must descend some time between 9:30 P. M. and 2:30 A. M. and ascend again at 4

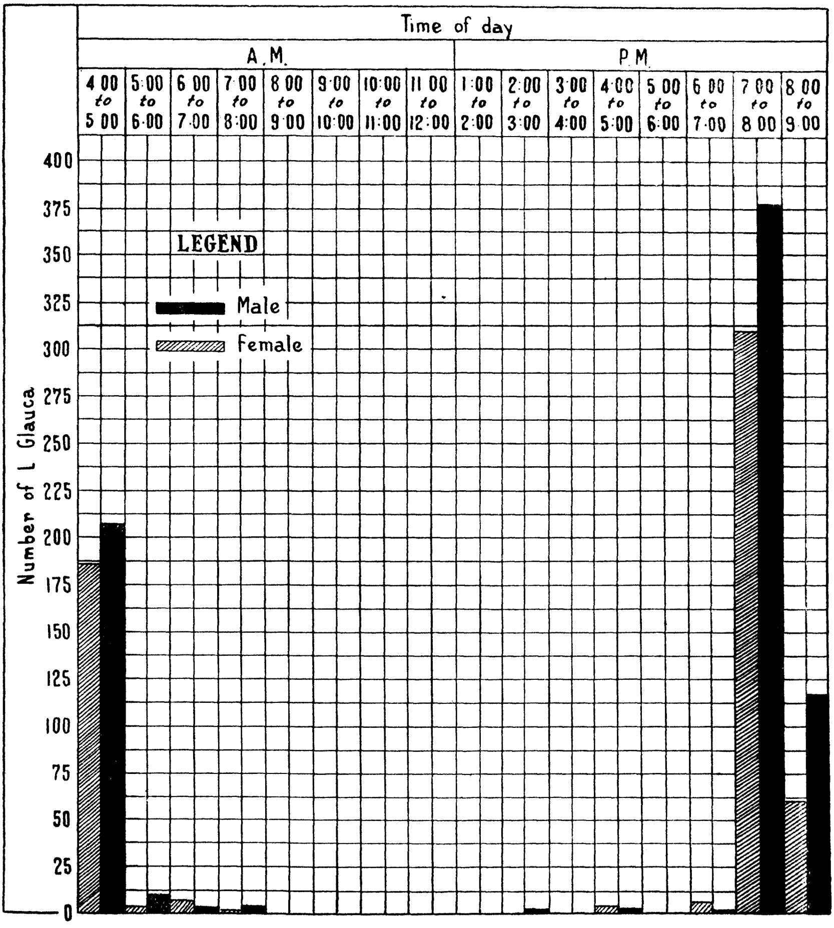

FIG. 3. Number and sex ratio of *L. glauca* according to time of day. Based on Table 1.

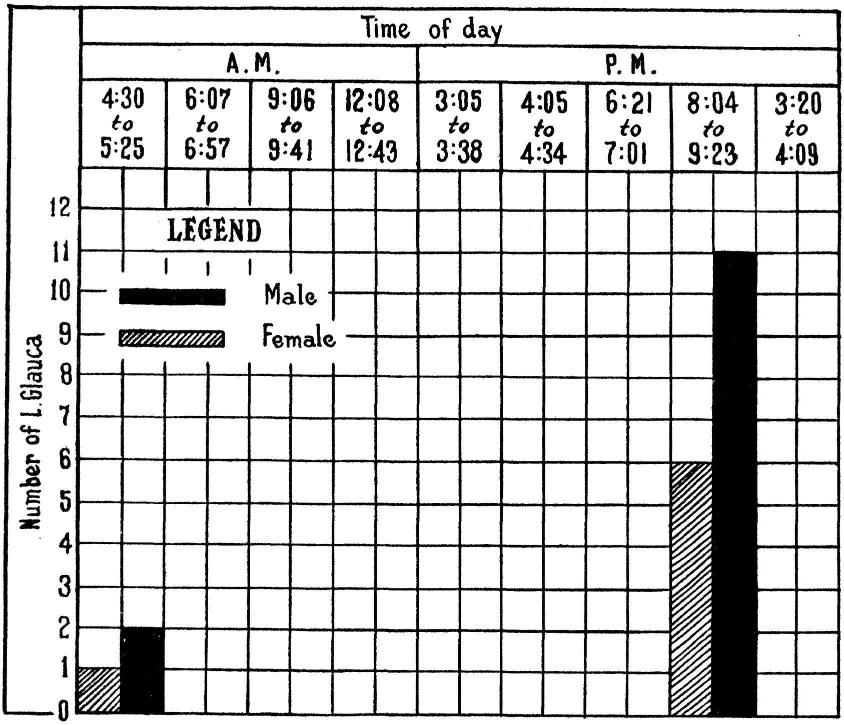

FIG. 4. Number of sex ratio of *L. glauca* according to time of day. Based on Tables 2 to 5.

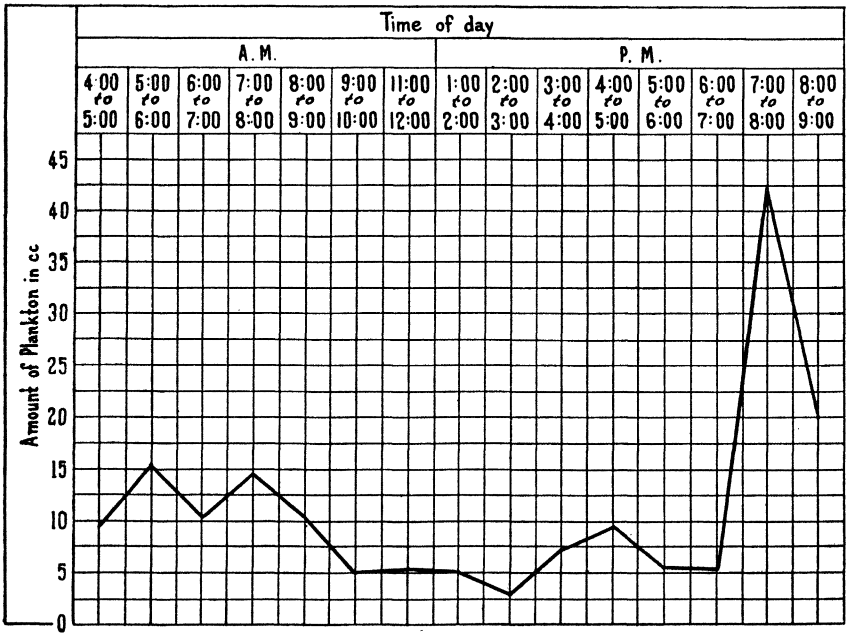

FIG. 5. Average amount of plankton according to time of day. Based on Table 1.

A. M. Whether or not *L. glauca* migrate to the surface between 9:30 P. M. and 2:30 A. M. was not determined in this investigation.

As to sex ratio, the males outnumbered the females in all of the migrations to the surface for both years (text figs. 3 and 4). In 1934 (text. fig. 4) the males had a greater preponderance over the females in the evening surface migrations than during 1933 (text fig. 3). The fact, however, that a comparatively large number of females do come to the surface with the males appears to indicate that both sexes have similar migratory habits.

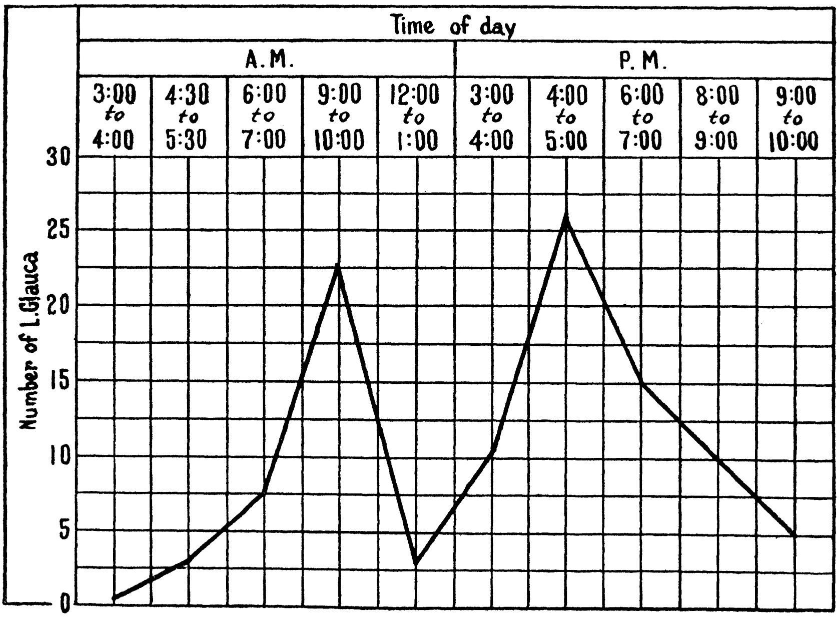

FIG. 6. Average amount of plankton according to time of day. Based on Tables 2 to 5.

There seemed to be no agreement according to the time of day between the average bulk of plankton (excluding *L. glauca*) collected during 1933 and that collected during 1934. Nor did there appear to be any correlation between the number of *L. glauca* and the average amount of plankton collected (text figs. 5 and 6).

REFERENCES

1. **Brady**, G. S. Marine copepod of New Zealand. Trans. Zool. Soc. **15** (1832) 31–54.
2. **Clarke**, G. I. Factors affecting the vertical distribution of copepods. Ecological monographs (4) 4 (1934) 530–540.

3. CHUN, C. Die pelagische Thierwelt in grossen Meerestiefen und ihre Beziehungen zu der Oberflächenfauna. Bibliotheca Zoologica **1** (1887) 1–66.
4. ESTERLY, G. O. The pelagic copepoda of the San Diego Region. Univ. Cal. Publ. Zool. **2** (1905–1906) 113–234.
5. ESTERLY, G. O. Additions to the copepod fauna of the San Diego Region. Univ. Cal. Publ. Zool. **3** (1906–1907) 53–92.
6. ESTERLY, G. O. The occurrence and vertical distribution of the Copepoda of the San Diego Region. Univ. of California Pub. Zool. **9** (1912) 253–340.
7. ESTERLY, G. O. Reactions of various plankton animals with reference to their diurnal migrations. Univ. Cal. Publ. Zool. **19** (1919) 1–83.
8. EWALD, W. F. Ueber Orientisierung, Lokomotion, und Lichtreaktionen einiger Cladoceren und deren Bedeutung fur die Theorie der Tropismen. Biol. Centralbl. **30** (1910) 1–16, 49–63, 379–384.
9. EWALD, W. F. On the artificial modification of light reactions and the influence of electrolytes on phototaxis. Journ. Exp. Zool. **13** (1912) 591–611.
10. FOWLER, G. H. Biscayan plankton—methods and data. Trans. Linn. Soc. Zoology **10** (1909) 1–11.
11. FRANZ, V. Weitere Phototaxisstudien: I. Zur Phototaxis bei Fischen. II. Phototaxis bei marinen Crustaceen. III. Phototaktische Lokomotionsperioden bei Hemimysis. Intern. Rev. Hydrobiol. U. Hydrogr. d. biol. Supp. XXXI (1911) 1–23.
12. GARDINER, A. C. Vertical Distribution in Calanus finmarchius. Journ. Mar. Biol. Assoc. n. s. **2** (1932–1933) 575–611.
13. GISBRECHT, W., and O. SCHMEIL. Das Tierreich—Crustacea—Acarina—Arachnidea (1898) 131–139.
14. GROOM, T. T., and J. LOEB. Der Heliotropismus der Nauplien von Balanus perforatus und die periodischen Tiefenwanderungen pelagischer Tiere. Biol. Centralbl. **10** (1890) 160–177.
15. HARMER, S. F., and A. E. SHIPLEY. Cambridge Natural History **4** (1909) 55–79.
16. HARPER, E. H. The behavior of the phantom-larvae of Corethra plumicornis Fabricius. Journ. Comp. Neurol. and Psychol. **17** (1907) 435–456.
17. HERDMAN, W. A., I. C. THOMPSON, and A. SCOTT. On the plankton collected continuously during two traverses of the North Atlantic in the summer of 1897, with descriptions of new species of Copepoda, and an appendix on dredging in Puget Sound. Trans. of Liverpool Biol. Soc. **12** (1897) 33–91.
18. KENZO, KIKUCHI. A Comparison of the diurnal migration of plankton in eight Japanese lakes. Mem. Coll. Sci. Kyoto Imperial Univ. ser. B art. 3 (1) **5** (1930) 27–75.
19. LUBBOCK, J. Description of a new genus of Calanidae. Ann. Nat. Hist. II **11, 12** (1853) 25–29.
20. LUBBOCK, J. On two new subgenera of Calanidae. Ann. Nat. Hist. II **11, 12** (1853) 202–210.
21. MENKE, H. Periodische Bewegungen und ihr Zusammenhang mit Licht und Stoffwechsel. Arch. Ges. Physiol. **140** (1911) 37–91.

22. MICHAEL, E. F. Classification and vertical distribution of the Chaetognatha of the San Diego region, including redescriptions of some doubtful species of the group. Univ. Calif. Pub. Zool. **8** (1911) 21–186.

23. PARKER, G. H. Reactions of copepods to various stimuli and the bearing of this on daily depth migrations. Bull. U. S. Fish. Com. **21** (1901) 103–123.

24. PECK, J. I. On the food of menhaden. Bull. U. S. Fish Com. for 1893 (1894) 351–368.

25. RUSSEL, F. S. The vertical migration of marine macroplankton. An observation on diurnal changes. Journ. Mas. Biol. Assoc. n. s. (4) **13** (1925) 769.

26. RUSSELL, F. S. The vertical distribution of marine macroplankton. Notes on the behavior of Sagitta in the Plymouth area. Journ. Mas. Biol. Assoc. n. s. **17** (1930) 391–405.

27. SCOTT, A. The Copepoda of the Siboga Expedition. Siboga Expeditie **44** (1909) 164–170.

28. SCOTT, T. Report on the Entomostraca of the Gulf of Guinea, collected by J. Rattray. B. Sc. Trans. Linnean Soc. II (Zool.) **6** (1893) 1–162.

29. THOMPSON, I. C. Revised report on the Copepoda of Liverpool Bay. Trans. Liverpool Biol. Soc. **7** (1893) 175–230.

30. WHEELER, W. M. Free swimming Copepoda of Woods Hole Region. Bull. U. S. Fish Com. **19** (1899) 157–193.

31. WILSON, C. B. The copepod plankton of the last cruise of the non-magnetic ship Carnegie—The Collecting Net. Sat. (Sept. 2, 1933) 1.

32. YERKES, R. M. Reactions of Entomostraca to stimulation by light. Am. Journ. Physiol. **3** (1899) 157–182.

ILLUSTRATIONS

PLATE 1. *Labidocera glauca* sp. nov.; × 50.

FIG. 1. Male; right lateral view.
2. Male, last thoracic segment; dorsal view.
3. Male, abdomen; dorsal view.
4. Male, first right antenna; right lateral view.
5. Male, second right antenna; right lateral view.
6. Male, right mandible and palp; anterior view.
7. Male, maxilla.
8. Male, second maxilla.
9. Male, maxilliped.
10. Male, 5th left leg.
11. Male, 5th right leg.
12. Female; lateral view.
13. Female, last thoracic segment.
14. Female, abdomen; dorsal view.
15. Female, first left antenna; dorsal view.
16. Female, first right leg; right lateral view.
17. Female, second right leg; right lateral view.
18. Female, third left leg; left lateral view.
19. Female, fourth right leg; right lateral view.
20. Female, fifth pair of legs; ventral view.

TEXT FIGURES

[Drawn by Francisco Rafael]

FIG. 1. Average number of *L. glauca* according to time of day. Based on Table 1.
2. Average number of *L. glauca* according to time of day. Based on Tables 2 to 5.
3. Number and sex ratio of *L. glauca* according to time of day. Based Table 1.
4. Number and sex ratio of *L. glauca* according to time of day. Based on Tables 2 to 5.
5. Average amount of plankton according to time of day. Based on Table 1.
6. Average amount of plankton according to time of day. Based on Tables 2 to 5.

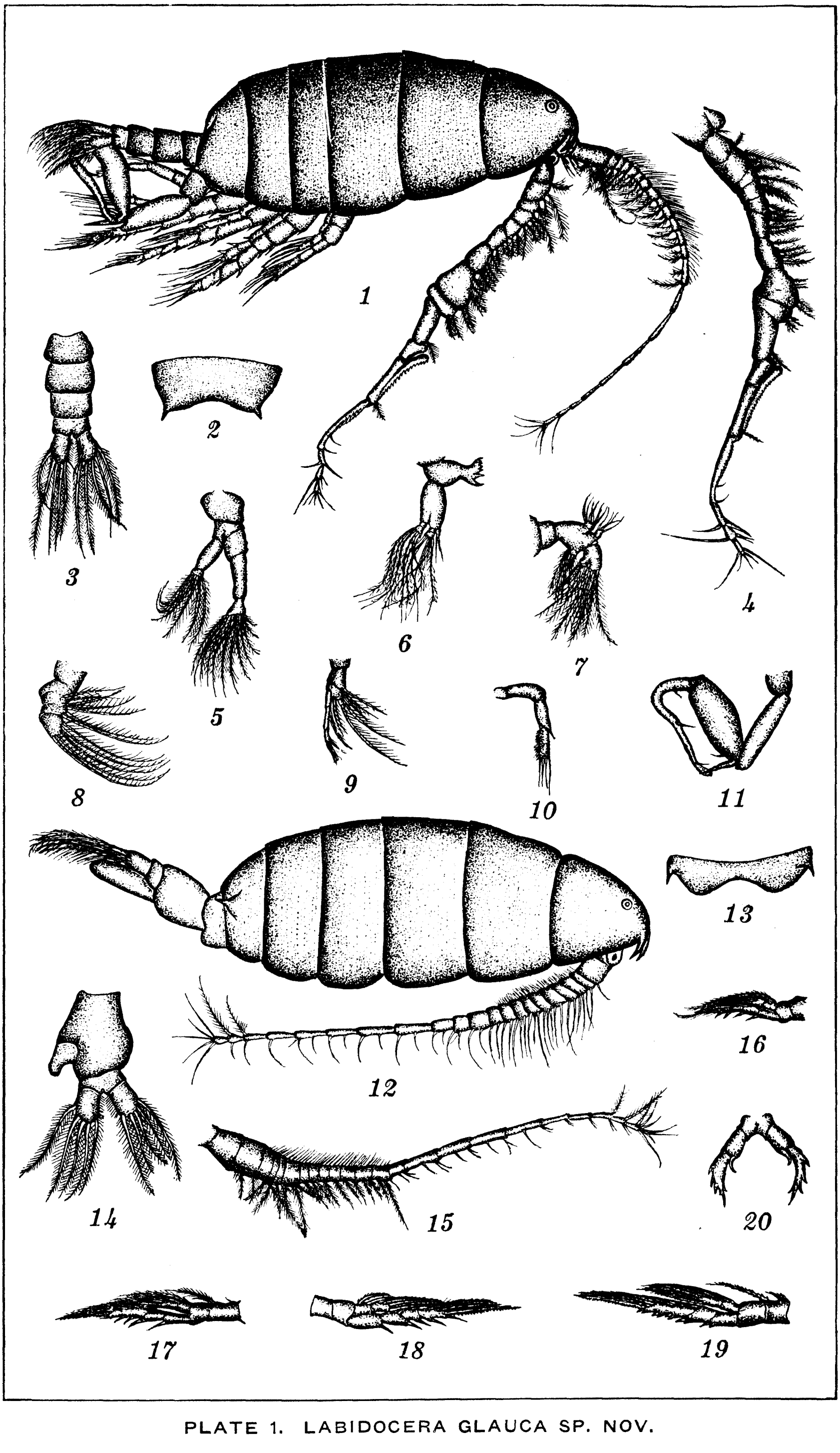

PLATE 1. LABIDOCERA GLAUCA SP. NOV.

UNIV. OF MICH.

BLATTODEA FROM LOS BAÑOS, LUZON, PHILIPPINES

By G. BEY-BIENKO

Of the Leningrad Agricultural Institute, Leningrad, USSR

SIX TEXT FIGURES

The present paper is based on a small collection of Blattodea made by Mr. N. Ikonnikov in the vicinity of Los Baños, Luzon, Philippines, in 1917, and submitted to me for study some years ago by Mr. A. Zhelokhovzev from the Zoological Institute of Moscow University.

The types of all new species are deposited in the Zoological Institute of Moscow University.

ECTOBIINÆ

Genus MARETA Bolivar

MARETA SUBCONTIGUA sp. nov. Text fig. 1.

LUZON, Laguna Province, Los Baños, April 25, 1917, 1 female (type) ; May 15, 1 female; May 22, 1 male? (abdomen missing) (*N. Ikonnikov*).

Very similar to *M. contigua* Walker from New Guinea, Malay Archipelago, Malay Peninsula, and Siam, in the presence of the porcelain-white crossbar on the head just above the antennal sockets, in the unusually long cerci, and in the presence of five branches on the anterior cubital vein (CuA) of the hind wings, but differs from it chiefly in the presence of numerous, somewhat elevated and plainly visible small dark-brown spots on the principal veins of elytra. Interocular space nearly equal to width between antennal sockets. Coloration of head brownish testaceous, with porcelain crossbar as described above; maxillary palpi very long, third and fourth joints very slender, subequal in length, fifth joint almost three-fifths as long as fourth. Pronotum with two pairs of brown dots on middle before hind margin (of which the anterior pair is much more approximated than posterior pair), two elongated, irregular, brown markings in median part, and two widely separated brown dots a little behind median markings. Elytra with numerous dots as described above, pale testaceous, extending a little beyond apex of cerci; R with fifteen oblique branches of which four or five apical branches are forked; mediocubital (discoidal) field with indistinctly oblique, practically longitudinal sectors. Wings with costal part pale testaceous; Sc with three thickened oblique branches, R with two thickened proximal branches, radiomedian field equal in width to mediocubital field, CuA with five regular branches, apical triangle narrow but distinct. Abdomen darkened above, testaceous below, very small, indistinct, dark lateral spots on the ventral surface of each segment. Supraanal plate strongly transverse, median part moderately produced, with a deep emargination so that the plate is bilobate; apex of each lobe pale, the rest of plate dark brown. Cerci very long and slender, with fourteen joints, apical joint subspiniform, not thicker than apical antennal joints; lower surface of cerci dirty testaceous, inner margin of upper surface blackened. Legs testaceous, fourth and apex of third joints of all tarsi blackened above. Anterior lower margin of anterior femora armed with a long row of pyliform spines, terminating in two large distal spines.

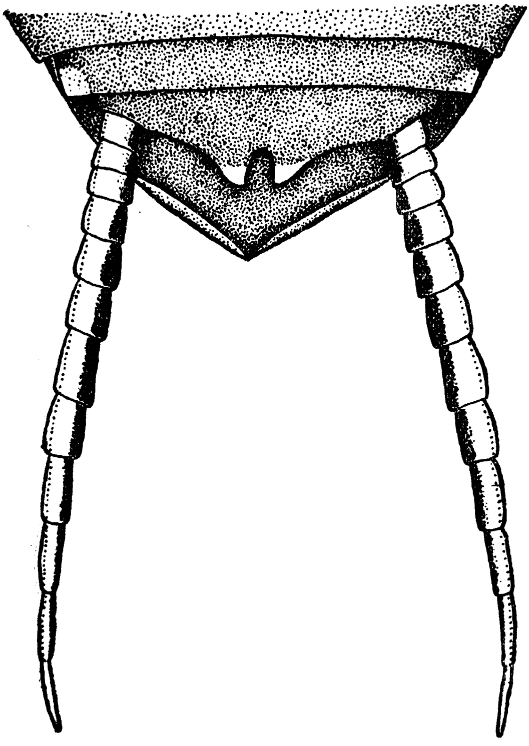

FIG. 1. *Mareta subcontigua* sp. nov.; apex of abdomen of female type, dorsal view.

Female.—Length of body 11.2 to 11.6 millimeters; pronotum 2.8; elytra 12.5; cerci 4.3 to 4.5; total length 15.5.

The present species shows a distinct affinity to some species of the related but independent genus *Grabtoblatta* Hebard, viz. *G. testacea* Hebard and *G. nodosa* Fritze, being characterized by the same general appearance, proportions of maxillary palpi, and even by the similar structure of the supraanal plate.

MARETA LUZONICA sp. nov. Text fig. 2.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 male (*N. Ikonnikov*).

A small species with very distinctive coloration of pronotum. General color testaceous. Face of head testaceous; upper part just above antennal sockets with a very broad porcelain-white crossbar partly occupying the lower part of vertex; upper part of latter brown, interocular space relatively broad, equal in length to third joint of maxillary palpi (other joints broken off); antennæ pale. Pronotum transverse, one and one-half times as broad as long, anterior and posterior margins practically straight; disc with a large, reddish-brown, trapezoidal spot, strongly broadening posteriorly, lateral margins of spot darker than median part, bordered with a narrow white line; lateral parts of pronotum hyaline. Elytra slightly narrowing apically, moderately extending beyond apex of abdomen, pale testaceous, without dark spots, veins and veinlets slightly whitish and opaque, producing a very delicate tesselation, basal part with a whitish stripe between Sc and R and with a narrower, dark-brown, bow-shaped stripe between basal fourth of R and M, oblique branches of R fourteen. Abdomen testaceous be-

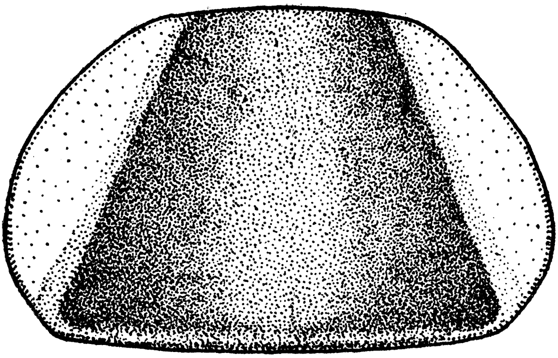

FIG. 2. *Mareta luzonica* sp. nov.; pronotum of male type.

low, with a small lateral brownish spot on each segment; supra-anal plate broadly triangular, short, apex slightly deflexed, with very feeble excision. Subgenital plate symmetrical, with a broad angular excision in middle, inner margin of each lobe straight, slightly reflexed, forming a narrow marginal rim; styli very small, subconical, a little longer than wide at base, placed on apex of each lobe. Cerci unicolorous, testaceous. Legs testaceous, typical for the genus.

Length of body 9 millimeters; pronotum 2; elytra 8.3; total length 10.3.

MARETA (?) DIAMESA sp. nov. Text fig. 3.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 male (*N. Ikonnikov*).

Very similar in general habitus and coloration to *Grabtoblatta testacea* Hebard from Java, but characterized by oblique sectors in the mediocubital field of elytra and therefore not congeneric with that species. On the other hand the new species is characterized by type C armament of anterior femora, but the apical part of the anterior lower margin of these femora is armed with three spines instead of two, as in typical members of the genus *Mareta*.

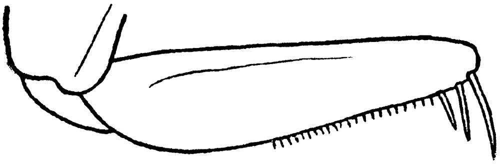

FIG. 3. *Mareta* (?) *diamesa* sp. nov.; anterior femur of male type.

Body unicolorous, pale. Head pale testaceous, without transverse band between eyes or antennal sockets, with very distinct convex ocellar spots; interspace between eyes equal in length to interspace between antennal sockets. Maxillary palpi with third and fourth joints normal, not elongated, fourth joint a little longer than third (fifth joint broken off). Pronotum irregularly pentagonal, one and a half times as broad as long, central part pale testaceous, immaculate, lateral parts hyaline. Elytra unicolorous, hyaline, extending beyond apex of abdomen at a distance twice as great as pronotal length, veins and veinlets slightly whitish and opaque, giving a very delicate reticulation (visible under magnification only). Mediocubital (discoidal) field with moderately oblique sectors. Abdomen pale testaceous, without dark spots near lateral margins of ventral surface.

Supraanal plate very short, strongly transverse, with moderately rounded hind margin. Subgenital plate symmetrical, with triangular excision in middle; styles moderately depressed, directed backwards, about twice as long as broad at base, moderately narrowing apically, but its immediate apex not sharpened; apex of each lobe of plate slightly produced in the shape of a very short, rounded lobule. Cerci pale testaceous. Legs pale testaceous, anterior lower margin of anterior femora armed with pyliform spinules only (type C), apex with three spines, of which the first spine is very short but distinct; other features typical for the genus.

Length of body 9.5 millimeters; pronotum 2.7; elytra 11.5; total length 13.5.

The systematic position of this species is intermediate between the genera *Mareta* and *Grabtoblatta,* although the principal morphological features (structure of the maxillary palpi, disposition of the sectors in the mediocubital field of elytra, and type C armament of the anterior lower margin of the anterior femora) are identical with those in the genus *Mareta.* The present species differs from the typical *Mareta* only in the presence of three, instead of two, apical spines on the anterior femora. *Grabtoblatta testacea* Hebard also widely differs from the typical members of the genus *Grabtoblatta* in the presence of a single large spine in the median part of the anterior lower margin of the anterior femora, whereas the genotype (*G. notulata*) is characterized by two or three median spines. On the other hand, the above described *Mareta subcontigua* sp. nov. is also characterized by somewhat intermediate characteristics and shows distinct affinity to *G. testacea* and *G. nodosa.* It is evident therefore that a revision of the entire group is badly needed.

Genus ALLACTINA Hebard

ALLACTINA JAKOBSONI Hebard.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female.

Originally described from Fort de Kock, Sumatra,(5) but subsequently recorded from northern Australia and Borneo,(4) Celebes,(2) Pahang, and Singapore;(1) the present record extends its area further northward.

ALLACTINA IKONNIKOVI sp. nov. Text. fig. 4.

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 male (*N. Ikonnikov*).

Head brownish yellow, with pale-yellow vertex, eyes moderately separated, interspace between them on vertex equal to interspace between antennal sockets and to fourth joint of maxillary palpi; maxillary palpi testaceous, slender, fifth joint moderately thickened, slightly shorter than fourth, the latter a little shorter than third. Antennæ black. Pronotum one and one-half times as broad as long, anterior and posterior margins slightly rounded, practically straight, disc with the center pale whitish, with two broad, longitudinal, brownish-black bands, fused behind and forming a broad ring open in front, median area with longitudinal, X-shaped, blackish-brown marking, pale-whitish border on anterior and posterior margins of pronotum of equal width, lateral parts of pronotum narrowly transparent. Scutellum black, with a whitish median triangular stripe. Elytra moderately narrowing apically, brownish, except marginal and anterior part of costoradial fields which are discolored; all veins and veinlets whitish, forming a very dense reticulation, apex of elytra roundish angular. Wings infumate, with costal margin reddish yellow; intercalated triangle very distinct. Abdomen reddish testaceous above and below, upper surface with indistinct brownish band along lateral margins. Supraanal plate strongly transverse, broadly triangular, slightly excised on middle. Subgenital plate symmetrical, with a relatively narrow triangular excision, hind margin of each lobe transverse, bearing a short, practically spherical stylus, placed at the angle between hind and external margins of the lobe. Cerci relatively long and slender, reddish testaceous. Legs testaceous, structure typical for the genus.

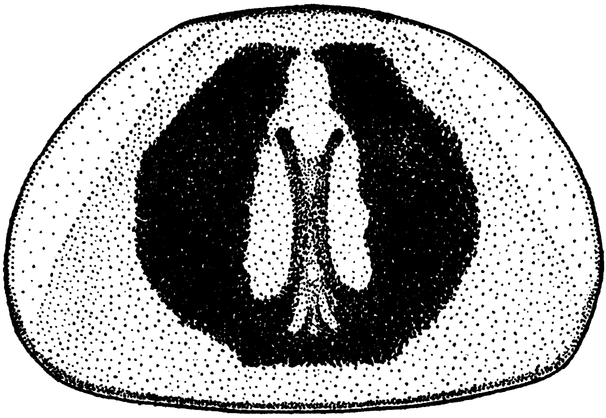

FIG. 4. *Allactina ikonnikovi* sp. nov.; pronotum of male type.

Length of body about 10 millimeters; pronotum 2.2; elytra 11; total length 12.6.

The pale-yellow vertex and the dense whitish reticulation on the elytra make this species easy to recognize.

Genus GRABTOBLATTA Hebard

GRABTOBLATTA NITULATA (Stål).

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 male.

A widely distributed species but previously unknown from the Philippines.

Genus PACHNEPTERYX Brunner

A very distinctive Philippine genus belonging to the subfamily Ectobiinæ. Shelford(6) includes it in the subfamily Phyllodromiinæ (Pseudomopinæ of recent authors) but probably without actual study of the genotype, *Pachnepteryx pruinosa* Brunner.

The genus was imperfectly known and a redescription is given below to supply a satisfactory definition.

Antennæ strongly plumose in both sexes. Head broadly triangular, sides strongly convergent toward mouth parts, distinctly concave just below eyes which are somewhat produced sidewise; maxillary palpi not elongate, fifth joint moderately broadened, equal in length to third and slightly longer than fourth. Pronotum scarcely broader than long, with a large black spot. Elytra corneous, with obscured venation, mediocubital field with longitudinal sectors. Wings with distinct but not broad apical triangle, oblique branches of Sc and R moderately thickened, CuA with only two complete incurved branches. Anterior lower margin of anterior femora armed with an elongate row of pyliform spinules (type C), terminating in two large distal spines, lower margins of other femora sparsely armed with delicate spines; tarsi with small pulvillus on each of four joints, tarsal claws moderately asymmetrical, simple, arolia large. Supraanal plate strongly transverse, in male moderately produced, with rounded hind margin, in female with very distinct, narrowly triangular excision in middle; subgenital plate in male asymmetrical, irregularly divided by a deep and narrow excision into two asymmetrical projections, without true styli.

Genotype: *Pachnepteryx pruinosa* Brunner.

PACHNEPTERYX PRUINOSA Brunner.

LUZON, Laguna Province, Los Baños, May 5 to 15, 1917, 3 males and 2 females.

From the material at hand the following additional diagnostic features of this species are drawn. Antennæ in female thicker than in male, with two light, broad bands, one of which is whitish and placed at the apex of the widest part, the second reddish yellow and placed in the apical half (apex of antennæ in male missing). Hind margin of pronotum with a narrow black border. Basal part of all coxæ black. Abdomen black above, with a narrow, reddish, lateral border, lower surface black, sides reddish, hind margins of sternites bordered with bluish or whitish; last sternite in female black, lateral part reddish; subgenital plate in male reddish, dextral process longer than sinistral.

Male, length of body 8 to 9.2 millimeters; pronotum 2 to 2.2; elytra 8.3 to 9.2; total length 10.3 to 11.5.

Female, length of body 8.5 to 8.8 millimeters; pronotum 2.3; elytra 8 to 8.6; total length 10 to 11.4.

Genus PACHNEBLATTA novum

Allied to *Pachnepteryx* but differing as follows: Body much broader. Pronotum distinctly transverse, about one and one-third as broad as long. Anterior lower margin of anterior femora armed with two or three long median spines, succeeded by a row of minute pyliform spinules, and terminating in three long distal spines; tarsal claws slightly unequal, practically symmetrical.

Genotype: *Pachnepteryx signaticollis* Stål.

To the same genus belongs *Pachnepteryx pallidicollis* Stål and probably *P. ventralis* Walker.

PACHNEBLATTA SIGNATICOLLIS (Stal).

LUZON, Laguna Province, Los Baños, April 5, 1917, 1 female; April 15, 1 male and 1 female.

Stål(8) in his description of *Pachnepteryx signaticollis* indicates the female sex, but Sjöstedt(7) has shown that the type specimen belongs to the male sex; after Sjöstedt's correction the identification of the species on the basis of Stål's short description is not difficult.

A short redescription of the species from the specimens before me and a description of the hitherto unknown male seems desirable.

Antennæ in female with a broad whitish band at middle, in male probably unicolorous, black (antennæ in male specimen partly missing). Head dirty reddish in male, face blackened in female; vertex in female testaceous, in male reddish yellow, occiput with three black (female) or reddish-brown (male), median longitudinal stripes, median stripe much broader and subdivided into two stripes; three basal joints of maxillary palpi pale, somewhat tinged with brown, two apical joints black. Pronotum with a large, rounded, pale spot on disc, bordered with bluish or whitish, and including a very distinct design in reddish brown (male) or blackish (female), containing three narrow, median, longitudinal stripes and many irregular symmetrically arranged spots and stripes; hind margin of pronotum with very narrow dirty-reddish, sometimes indistinct border, lateral parts transparent. Elytra piceous, with very dense, small, whitish points, marginal field and anterior margin of elytra subhyaline. Wings infumate. Lower surface of abdomen in male reddish yellow, in female brownish, with reddish lateral spots, hind margin of sternites bordered with bluish. Supra-anal plate strongly transverse, in male with moderately rounded hind margin, in female with median part produced and triangularly excised. Subgenital plate in male with a deep median excision, dextral part with a long projection, which is narrowed apically and bears an irregular, indistinctly separated stylus, sinistral part very short, with a short styliform projection. cerci relatively short, in male reddish yellow, in female black. Legs in male pale testaceous, in female blackened at bases of coxæ, upper surface, femora, tibiæ, and tarsi; spines pale.

Male, length of body 8 millimeters; pronotum 2.5; elytra 10.2; total length 12.3.

Female, length of body 9 to 9.5 millimeters; pronotum 2.3 to 2.5; elytra 9.6 to 10; total length 12.

Genus MARGATTEA Shelford

MARGATTEA INVALIDA sp. nov. Text fig. 5.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 male (*N. Ikonnikov*).

A slender, contrastingly colored species. Head unicolorous, pale testaceous, with very distinct, pale, ocellar spots, interspace between eyes relatively broad, equal to interspace between antennal sockets, maxillary palpi concolorous, not elongate, fifth joint moderately broadened, subequal in length to fourth, fourth joint slightly shorter than third. Antennæ one and one-half times as long as body, black on entire length, except for two basal joints and upper part of third joint which are pale testaceous, and a narrow stripe on sixth to eighth joints which is brownish. Pronotum transverse, one and one half times as broad as long, anterior margin slightly rounded, posterior margin between shoulders straight; disc reddish testaceous, with feeble reddish tinge, without dark stripes or spots, lateral parts hyaline. Elytra extending far beyond apex of abdomen, slightly narrowing apically, R distinctly sinuate in basal half, with fourteen or fifteen oblique branches, some apical branches forked, mediocubital field with very slightly oblique, practically longitudinal sectors; coloration dark brown with a broad but apically narrowing pale border along costal margin. Wings infumate, with pale-testaceous border along costal margin. Abdomen reddish testaceous below, tinged with brown above; supraanal plate strongly transverse, hind margin obtusely angulate; subgenital plate symmetrical, with a profound rectangular emargination in middle, each lobe triangular, with very short, practically spherical stylus on apex (basal part of cerci pale testaceous, other part broken off). Legs testaceous, anterior lower margin of anterior femora with a single, relatively small median spine, succeeded by a long row of pyliform spinules terminating in two large distal spines, genicular spines on the median and posterior femora long, slightly longer than fourth joint of maxillary palpi; spines of lower

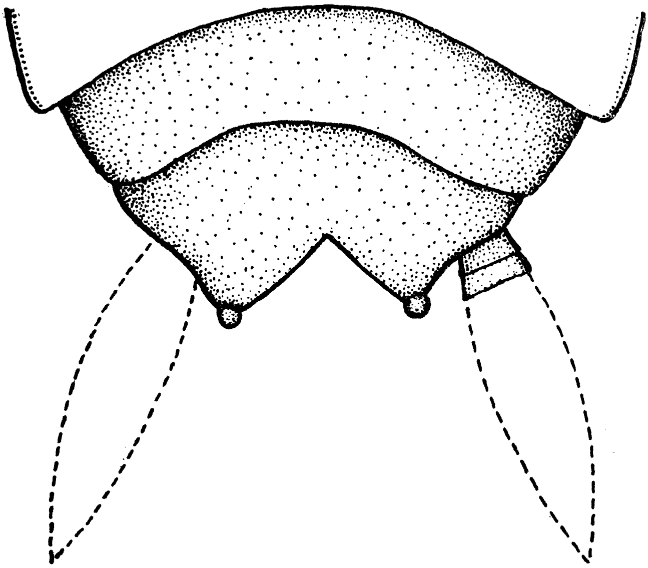

FIG. 5. *Margattea invalida* sp. nov.; apex of abdomen of male type, ventral view.

margins of median and posterior femora not numerous, relatively long, delicate.

Length of body 8.1 millimeters; pronotum 2.1; elytra 9.3; total length 10.8.

A distinctive species easily recognized by its coloration and by the presence of a single, elongate, median spine on the anterior lower margin of the anterior femora.

PSEUDOMOPINÆ

Genus BLATTELLA Caudell

BLATTELLA LITURICOLLIS Walker.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 female.

A widely distributed species; hitherto not recorded from the Philippines. The specimen agrees well with a typical series from southeastern China.

Genus PARASYMPLOCE Hebard

PARASYMPLOCE MARGINALIS Hanitsch?

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female.

The arrangement of the fulvous border of the pronotum agrees with the description of Hanitsch(3) for *P. marginalis* from the Malay Peninsula, but the disc of the pronotum is brownish piceous.

Head brownish ferrugineous, unicolorous; basal part of antennæ dirty testaceous, blackish toward apex. Pronotum with pale-fulvous border on the lateral and anterior margins, disc brownish piceous. Elytra extending beyond apex of abdomen at a distance equal to pronotal length; coloration castaneous, marginal field pale fulvous; R forked slightly before its middle, with nineteen oblique, simple branches. Wings infumate. Abdomen pale testaceous below, with a pair of lateral brown spots on each segment; supraanal plate broadly triangular, apex with a shallow angular excision. Cerci pale fulvous above, tinged with brown below. Legs testaceous, typical for the genus.

Length of body 13 millimeters; pronotum 3.3; elytra 12.7; total length 16.5.

EPILAMPRINÆ

Genus EPILAMPRA Burmeister

EPILAMPRA CYRTOPHTHALMA Stål?

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 female.

Stål's(8) description is very short and vague.

The present specimen is characterized as follows: Coloration flavotestaceous. Interocular-ocellar region and occiput with dense brown points and some less numerous and larger spots, eyes wide apart, interspace between them a little narrower than interspace between antennal sockets and about twice as great as width of an eye on anterior part of head. Antennæ ferruginous. Pronotum with dense ferruginous points, but without longitudinal stripes before hind margin. Elytra with irregular ferruginous fine borders along actual and false veins; R with some irregular dark-brown spots on basal half. Lower surface of abdomen with relatively dense, ferruginous points and spots but without black lateral spots, cerci pale testaceous, with extreme apex blackened; supraanal plate roundly triangular, with a deep acute-angulate median excision. Bases of tibial spines, apical parts of all tibiæ and of tarsal joints blackened, anterior lower margin of anterior femora with four median and one apical spines and one intermediate series of small spinules, hind margin with four stout spines, hind metatarsus equal in length to remaining joints.

Length of body 24 millimeters; pronotum 5.9; elytra 22; total length 28.5.

EPILAMPRA LUZONICA sp. nov. Text fig. 6.

LUZON, Laguna Province, Los Baños, May 22, 1917, 2 males (including type) and 1 female (*N. Ikonnikov*).

Male pale testaceous, female much darker, brownish testaceous. Head distinctly depressed anteriorly; interocular space with a black band, quite flat, seen in profile forming with occiput a very distinct angle, in male relatively narrow, nearly twice as broad as width of an ocellus, interspace between antennal sockets about twice as broad as interocular space; in female interocular space broader, about three times as broad as width of an ocellus, interspace between antennal sockets only one and one-half times as broad as interocular space; maxillary palpi short, all three apical joints subequal in length, fifth joint slightly darkened. Antennæ blackish brown, except some basal joints which are pale. Pronotum a little less than one and one-half times as broad as long, anterior margin slightly rounded, lateral portions obtuse-angulate, hind margin bisinuate, with median part roundly produced; surface without marked depression, covered with dense reddish (in male) or blackish-brown (in female) spots, hind part with four longitudinal stripes of same coloration on the produced median part. Elytra in male sur-passing apex of abdomen at a distance subequal to pronotal length, in female at a distance equal to one-half pronotal length; coloration in male pale testaceous, with indistinct and sparse reddish spots. Sc whitish pale; coloration of elytra in female pale greenish, with more distinct and more numerous reddish-brown spots. Wings testaceous along costal margin, cinereous in other part. Abdomen pale, lower surface with a pair of black spots on each segment, placed along lateral margin, and with sparse, blackish-brown points. Supraanal plate hyaline, with hind margin semicircular, in male with a feeble, shallow, obtuse, median emargination, in female with deeper, acute-angulate excision in middle; subgenital plate of male hyaline, transverse, symmetrical, with two very delicate styli, hind margin obtusely angulate, cerci pale, relatively short. Legs pale, anterior coxæ with black basal spot and less sharp, brownish (male) or brownish-black (female) median spot, tarsi slightly darkened; all femora in female with darkened upper margin; anterior lower margin of anterior femora with three or four median spines, a single apical spine and an intermediate series of small spinules; hind metatarsus equal in length to remaining tarsal joints.

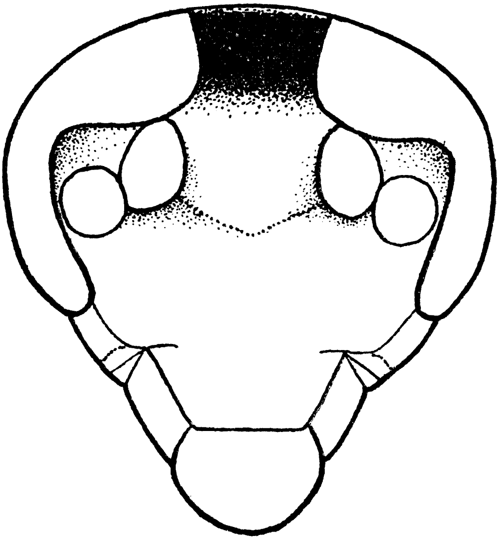

FIG. 6. *Epilampra luzonica* sp. nov.; head of male type.

Male, length of body 18 millimeters; pronotum 4 to 4.2; elytra 17; total length 21.5 to 22.

Female, length of body 23 millimeters; pronotum 5.2; elytra 21; total length 27.

The present species may be easily distinguished by the structure and coloration of the head.

LITERATURE CITED

1. HANITSCH, R. Fauna Sumatrensis. Blattidæ. Tijdschr. voor Entom. **80** (1929) 263–302.
2. HANITSCH, R. The blattid fauna of Celebes, based chiefly on the collections made by P. and F. Sarasin. Verh. Naturforsch. Ges. Basel **44** (1933) 119–150.
3. HANITSCH, R. The Blattidæ of Mount Kinabalu, British North Borneo. Journ. Feder. Malay States Museum pt. 2 **17** (1933) 297–337.
4. HANITSCH, R. Blattids from Java and northern Australia. Rev. Suisse Zool. **41** (1934) 111–130.
5. HEBARD, M. Studies in Malayan Blattidae (Orthoptera). Proc. Acad. Nat. Sci. Philad. **81** (1929) 1–109, 6 pls.
6. SHELFORD, R. Genera Insectorum fasc. 73. Orthoptera, Blattidæ, Phyllodromiinæ. (1908) 29 pp., 2 pls.
7. SJÖSTEDT, Y. Orthopterentypen im Naturhistorischen Reichsmuseum zu Stockholm. 6. Blattidae. Arkiv för Zool. A (15) **25** (1933) 1–17.
8. STÅL, C. Orthoptera nova ex Insulis Philippinis. Ofvers. Kongl. Vetensk.-Akad. Förhandl. No. 10 (1877) 33–58 [Blattina pp. 33–57].

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Mareta subcontigua* sp. nov.; apex of abdomen of female type, dorsal view.
2. *Mareta luzonica* sp. nov.; pronotum of male type.
3. *Mareta* (?) *diamesa* sp. nov.; anterior femur of male type.
4. *Allactina ikonnikovi* sp. nov.; pronotum of male type.
5. *Margattea invalida* sp. nov.; apex of abdomen of male type, ventral view.
6. *Epilampra luzonica* sp. nov.; head of male type.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Knowing Your Trees. By G. H. Collingwood. Washington, D. C., The American Forestry Association, 1940. Fourth printing. 109 pp., illus. Price, $1.

This book presents to the reading public information concerning the life, habitat, and characteristics of each tree, together with the botanical features, uses, economic importance, and other details that distinguish one tree from another. The language is easily understood, as the use of technical terms has been avoided wherever possible. The book gives descriptions of fifty trees belonging to the most commonly known coniferous and broad-leafed species of the United States. The discussion of each tree is supplemented by photographs showing the leaves, fruit, bark, and frequently one of the blossoms. The condition of the twigs of the deciduous broad-leafed trees during winter and summer are also shown. The natural range of each species is shown on an outline map of the United States.

This book is recommended to students, botanists, foresters, and lay persons interested in trees. A selected bibliography is found at the end of the discussion. An index of common and scientific names facilitates the use of the book.—P. D.

Kingdom of the Trees. By Erle Kauffman. Chicago, The Reilly and Lee Company, 1940. 122 pp., illus. Price, $2.

This book is intended particularly for the boys and girls of America. It is written in the form of a story, being narrated by an old forester to two children. The author has made the book interesting by using the trees as characters. Anecdotes, stories, and tales are skillfully woven into the narration of the life of the trees, their importance, requirements for growth, and service to humanity. Among the trees mentioned by the author are the elm as "The Tree of Glory", the maples as the "Tree Farmers" producing sugar, the fir and holly as Christmas trees, and trees linked with great Americans. Among the trees of the forest there are "farmers, doctors, teachers, loafers and kings."

It is a book that will greatly help a teacher in his class in nature study, and in arousing interest among children in the proper care and regard for the trees about them. It contains many beautiful illustrations. At the end of the book is a table which serves as a guide in the identification of the trees mentioned in the text.—P. D.

The Home Book of Trees and Shrubs. By J. J. Levison. New York, Simon and Schuster, Inc., 1940. 424 pp. Price, $5.

This book is a record of some of the lessons the author has gleaned from his mistakes, experiments, and experiences during the last three decades of active service as forester in charge of the parks and street trees of Brooklyn and New York City, and as consultant to hundreds of private estates and institutions. It is written in a popular style, so that laymen or amateur gardeners can obtain from it authentic simple information on the necessity of having a definite plan for the home grounds; important considerations in selecting planting materials; best trees and shrubs for various sites and locations and their care; determination of what every tree needs and how to supply it; pruning, repair, and protection of trees and shrubs; common insect pests and diseases, and how to control them; determination of the need for a wooded portion of the home grounds, its care, maintenance, and improvement; planning, establishment, fertilizing, seeding, and care of lawns; use, selection, and arrangement, of flowering plants; and the selection of accessories, like garden furniture and shelters, fences, tennis courts, and the like, which should be not only attractive, but also suited to the environment.

Descriptions are given of typical gardens and popular misconceptions and fallacies about trees and shrubs for home ground planting, supplemented with photographs of views of different portions of the garden.

As an aid in the selection of trees for planting on suburban and country home grounds the author classifies the trees under four headings; namely, deciduous trees of the large-growing kind, deciduous trees of the small-growing species, large evergreen trees, and small evergreen trees. A list is given of the trees arranged in the order of preference.

A working program for every month of the year is presented. The author has found this system helpful in handling the numerous estates in his charge as consultant.

Of interest to the florist is a list of flowers, showing the color, full period and time of blooming, height of the plant, distance of planting, perennial, biennial, or annual varieties, light and soil requirements, and other information, as on cut flowers, easily grown flowers, flowers hard to keep, and so on.

The book contains information which every one interested in beautiful home grounds should have as a ready reference. The photographs of homes and various kinds of gardens are inspiring. Insect pests, diseases, individual trees, methods of planting, and many other topics are illustrated in the text.—P. D.

The New York Hospital Handbook of Applied Nutrition. Published by the New York Hospital. New York, 1939. 136 pp., front., illus.

This booklet contains menus recommended for the different meals of the day for patients under different conditions of treatment in the hospital. The amounts of the various items are given in grams as well as in terms of common household units of measurement. The total caloric value, the calories for fats, carbohydrates, and proteins are given for each group of 24-hour menus. A special feature of the booklet are the simplified standards for caloric requirement for total energy, fats, carbohydrates, and proteins which are given per kilogram of body weight, so that a general diet recommendation may be made without going through complicated computations. There are appended the usual tables of compositions of single foods, vitamin charts, and age-height-weight tables.

This handbook is a necessary addition to every hospital library.—N. C.

Mineral Metabolism. By Alfred T. Shohl. New York, Reinhold Publishing Corporation, 1939. 384 pp. Price, $5.

This comprehensive, up-to-date review of the rôle played by each of the different inorganic salts in various metabolic processes gives a detailed description not only of the mineral composition of the body, but also of the inorganic contents of secretions, excretions, and endocrines, and the changes observed in the mineral economy under various abnormal conditions such as dehydration, diabetes insipidus, Addison's disease, and parathyroid disturbances.

Particular emphasis is devoted to the metabolism of calcium, phosphorus, iron, and iodine, whose absorption, intermediary metabolism, and excretion have been carefully described. The pages on ricketts, tetanus, hypochromic anæmias, and goitre are illuminating. Finally, the mineral intake and mineral requirements at various ages and conditions are taken up, together with a description and critique of the general procedures used in mineral balance studies.—J. S. Jr.

Vitamin E. A Symposium Held Under the Auspices of the Food Group (Nutrition Panel) of the Society of Chemical Industry on Saturday April, 22, 1939, at the School of Hygiene and Tropical Medicine, London, England. New York, Chemical Publishing Co., Inc., 1940. 88 pp., illus. Price, $2.

This symposium is an excellent presentation of a combination of publications by researchers and clinicians in the basic medical sciences. The book is divided into three parts; namely, chemistry of tocopherol or vitamin E; physiologic action of vitamin E and pathology of avitaminosis–E; and clinical application of vitamin E therapy.

Vitamin E can be isolated from wheat-germ oil as crystalline alcohols; namely, A and B-tocopherol. A-tocopherol has the formula $C_{29}H_5O_2$, and is active in rats at a dose of 2 to 3 milligrams. B-tocopherol has the formula $C_{28}H_{48}O_2$, and is active at a dose of about 5 milligrams. γ-tocopherol, isomeric with and of the same biologic activity as B-tocopherol, has been isolated from cottonseed oil. Biologic activity is dependent on the length of the aliphatic side chain and on the number of methyl groups in the tocopherol molecule; a long side chain and the presence of three methyl groups being most favorable in A-tocopherol. Quantitative chemical tests for the vitamin are given.

Prominent effects of E deficiency in rats are gestation resorption in females and slow degeneration of spermatogenic tissue in males. Other effects are discoloration of uterus and seminal vesicles, paralysis of hind limbs, skin sores, emaciation, and death. Attempts have been made to explain the underlying pathogenesis of the above defects. Some authors believe that vitamin E deficiency is a simple pituitary deficiency. Others call attention to the possibility of pituitary hormone inbalance in vitamin E deficiency. Some workers suggest that the vitamin acts directly on the gonads and thereby indirectly affects the pituitary. Studies are given showing that placental transfer of vitamin E in rats is negligible, while maternal (mammary) transfer is very limited. A bioassay of the vitamin is described.

The clinical application of vitamin E therapy was first tried in 1931, nine years after the discovery of the vitamin in the therapy of frequent, noninfectious barrenness (sterility and abortion) in cows in Denmark with 75 per cent of 1,200 animals becoming pregnant. P. Vogt-Moller reported two series in man, one of 20 and the other of 52 cases, of habitual abortion in which no anatomical, physiological, or pathological abnormalities could explain the condition. Administration of wheat-germ oil (3 grams daily) resulted in the birth of living children in 17 and 38 cases respectively. These women were subjected also to serological and hormone tests. Their husbands were found with normal spermatozoa. Evan Shute claims that vitamin E deficiency in women may be diagnosed by measuring the resistance of blood sera to proteolysis, in addition to clinical signs as a hypothyroid appearance, a small area of uterine tenderness localized in the placental site, hypertension, albuminuria, and termination of pregnancy before maturity with deformed infants. The usual dose recommended is 1 to 2 drams of wheat-germ oil daily or one 3-minim capsule of the concentrate of the oil equivalent to 6 milligrams tocopherol daily for about 18 weeks.—J. S. Jr.

Marihuana. America's New Drug Problem. A Sociologic Question With its Basic Explanation Dependent on Biologic and Medical Principles. By Robert P. Walton. With a Foreword by E. M. K. Geiling. Philadelphia, J. B. Lippincott Co., 1938. 223 pp., plates. Price, $3.

Dr. Robert P. Walton presents here in a scientific and systematic manner all available data on marihuana, which in recent years has become a deadly menace in the United States. This monograph gives the history of the marihuana vice and the countries affected by this drug habit, with particular reference to its present status in the United States. The source from which this drug is obtained, the method of administration and the experience of those who use it are described in this book.

Other topics discussed are the following: acute effects, chronic effects, therapeutic application, and pharmaceutical and chemical considerations relating to the drug.

Professor Walton states that his book is primarily a reference for those seeking information on this drug and the use of it.—A. O. C.

Field Trials: Their Lay-out and Statistical Analysis. By John Wishart. Cambridge, England, School of Agriculture, 1940. 36 pp. Price, paper 2s/6d.

This bulletin is a very handy reference for beginners in field experiments and much more so for plant breeders. The author wrote it as nearly as possible in nontechnical language, and whatever technical terms are used are defined. As an exposition of the method of laying out field trials and of the statistical analysis of the results, it contains an introduction to the measurement of experimental error, test of significance, method of randomized blocks, general method, method of the Latin square layout, multifactor experiments, split-pilot experiments, confounding, and experiments with a large number of varieties. It likewise serves as an introduction to the more complex problems of field experimental procedures and analysis of factorial experiments and to other books which give detailed methods on the subject. References for further reading are included in this bulletin.—M. S. S.

Electrocapillarity. By John Alfred Valentine Butler. New York, Chemical publishing Co., Inc., 1940. 208 pp., illus. Price, $5.

This book deals with the physical and chemical phenomena arising from differences of potentials at the surface of contact of electrified bodies. The subject is broad in scope, touching all points related to electrodes and other charged surfaces. It begins with the important discoveries made by Galvani and Volta, which later on became the object of further experimentations by various workers. In the chapters that followed, the different complicated problems regarding potential differences under different conditions, the points of views of various experimenters on their respective subjects bearing relation to potential differences, and the points of view of the author are amply discussed and illustrated.

Although the chemistry and physics of electrodes is not a new science, the subject as discussed in this book is interesting, not only because of the manner in which it is presented and developed but also because the problems treated have an important bearing on industry and biology. It is a valuable book, especially for those devoted to the study of electrochemical phenomena.—R. H. A.

Time and its reckoning. By R. Barnard Way and Noel D. Green. New York, Chemical Publishing Co., Inc., 1940. 137 pp., front., illus. Price, $2.

This is an essentially popular account of how time has been kept throughout the ages. Considerable useful knowledge is imparted in a clear and simple, though somewhat profuse way.

May we call attention, however, to a few defects or errors which, in case of a possible second edition, we hope to see corrected? On page 27, in speaking of the proposed reform of the calendar, reference is made only to the thirteen-month scheme and not to the revision retaining twelve months which seems more in favor at present. On page 115, bottom line, the word "meridian" should be "latitude." The account of the new and very important quartz crystal chronometers should have been more ample. Finally, we hardly think that the very small and elementary chapter on the nature of time at the end of the book suffices to fulfill the promise made at the beginning to treat the metaphysical aspect of time.—C. E. D.

RECEIVED

A. S. T. M. Standards on textile materials. Prepared by Committee D-13 on textile materials. Specifications, tolerances, methods of testing, definitions and terms. October, 1940. Philadelphia, The Society, 1940. 368 pp., illus. Price, $2.

BOAS, FRANZ. Race, language and culture. New York, The Macmillan co., 1940. 647 pp., illus. Price, $5.

COLE, LEWIS GREGORY, and WILLIAM GREGORY COLE. Pneumoconiosis (silicosis); the story of dusty lungs, a preliminary report. New York, John B. Pierce Foundation, 1940. Separately paged, illus.

HIMES, NORMAN E., and others. Practical birth-control methods. New York, Modern age books, 1939. 254 pp., illus. Price, $1.49.

KESO, EDWARD E. Conserving our resources. Oklahoma City, Times-Journal publishing co., 1940. 206 pp., illus. Price, $0.98.

MAIRET, ETHEL M. Vegetable dyes. New York, Chemical publishing co., inc., 1939. 68 pp. Price, $2.

MATTHEWS, F. J. Boiler feed water treatment. 2d ed. rev. and enlarged. New York, Chemical publishing co., inc., 1939. 319 pp., illus., plates. Price, $5.

SNELL, FOSTER DEE, and CORNELIA T. SNELL. Chemicals of commerce. New York, D. Van Nostrand co., inc., 1939. 542 pp. Price, $5.

WAY, R. BARNARD, and NOEL D. GREEN. Time and its reckoning. New York, Chemical publishing co., inc., 1940. 137 pp., front., illus. Price, $2.

HALDANE, J. B. S. Science and everyday life. London, Lawrence and Wishart ltd., 1939. 284 pp. Price, 5s/—.

HUTTON, ISABEL EMSLIE. The hygiene of marriage. 8th ed. London, William Heinemann (Medical books) ltd., 1940. 152 pp., illus. Price, 5s/—.

KIRKENDALL, LESTER A. Sex adjustments of young men. New York, and London, Harper & brothers, 1940. 215 pp. Price, $2.

NEWELL, ADNAH CLIFTON. Coloring, finishing and painting wood. Peoria, Illinois, The Manual arts press, 1940. 480 pp., illus. Price, $4.50.

SKINKLE, JOHN H. Textile testing, physical, chemical and microscopical. New York, Chemical publishing co., inc., 1940. 272 pp., illus. Price, $3.

TAYLOR, F. SHERWOOD. Science front 1939. London, Toronto, Melbourne and Sydney, 1939. 301 pp., illus. Price, $2.50.

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GLEICHENIACEÆ OF NEW GUINEA

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SIX PLATES

The genus *Gleichenia*, construed, as has long been the practice, to include almost the entire family Gleicheniaceæ, is a natural genus, just as *Trichomanes* would be if made to include all Hymenophyllaceæ. But it is very diversified, and is becoming inconveniently large. It should be broken up, if the resulting genera can be likewise natural and easily recognized. This happens to be easy; and, being so, it has been done, in part, earlier but thoroughly by Presl. Christensen[1] has revived some of the old names, recognizing 5 genera. In the following treatment of the New Guinea species I follow Christensen, except for the resurrection of one more Preslian genus, *Hicriopteris*. The family then includes 2 monotypic genera with simple pinnate fronds, besides the 4 following, represented in New Guinea.

Key to the New Guinea genera of Gleicheniaceæ.

a^1. Segments minute, round or roundish.. 1. *Gleichenia*.
a^2. Segments much larger and longer.
  b^1. Fronds pectinate (once-pinnate) above highest fork.
    c^1. Veinlets several, sporangia more than 6.................. 2. *Dicranopteris*.
    c^2. Veins once-forked, sporangia up to 6.............................. 3. *Sticherus*.
  b^2. Frond bipinnate above last fork.. 4. *Hicriopteris*.

1. Genus GLEICHENIA Smith

Frond bipinnate or more compound; segments minute, round or ovate; sori usually composed of 3 or 4 sporangia. A small genus of the Oriental Tropics and farther south. *Platyzoma*,

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[1] Verdoorn's Manual of Pteridology (1938) 530.

with one Australian species, differs in having a narrowly linear frond, the segments borne on the primary rachis.

Key to the New Guinea species of Gleichenia.

a^1. Segments cucullate, with small opening beneath........ 1. *G. circinnata.*
a^2. Segments bullate, neither surface exposed.
  b^1. Lamina bearing peltate scales beneath........................ 2. *G. peltophora.*
  b^2. Lamina without peltate scales............................... 3. *G. squamosissima.*

1. GLEICHENIA CIRCINNATA Swartz.

Brass 12624, altitude 2,150 meters in *Sphagnum*. This specialtitude 2,400 meters. Long reported from New Guinea. Report of *G. dicarpa* in New Guinea probably refers to what is here called *G. circinnata.*

South to New Zealand; occurrence in Philippines and Malaya is subject to confirmation.

2. GLEICHENIA PELTOPHORA Copeland.

Gleichenia borneensis (Baker) C. CHRISTENSEN, Gardens' Bull. 7 (1934) 211.

Brass 12624, altitude 2,150 meters in *Sphagnum*. This specimen has small, appressed, brown paleæ on the axes; these are found on the buds of the type collection, but are caducous or absent elsewhere.

MINDANAO, Mount Matutum. BORNEO, Mount Kinabalu.

3. GLEICHENIA SQUAMOSISSIMA Copeland sp. nov. Plate 1.

Rhizomate late repente, 2 mm crasso, castaneo, lignoso, paleis fuscis cinerascentibus deciduis subvestito; stipite 10 cm alto, 1.5 ad 2 mm crasso, deorsum castaneo mox nudo, sursum paleis cinerascentibus appressis laceris vestito, tum demum plus minusve glabrescente et asperulo; lamina usque ad 25 cm alta, rigida, erecta, bipinnata, haud furcata; rhachi ubique dense paleacea, paleis majoribus 2 ad 3 mm longis ovatis patentibus margine mox laceris albidis, minoribus et minutis appressis varie dissectis; pinnis 2 ad 4 cm longis, circa 2 mm latis, erecto-patentibus, ad costam crassam pinnatis, costa superne decidue fibrillosa, inferne paleis circa 1 mm longis ovatis acuminatis ferrugineis laceris segmenta occultantibus immersa; segmentis vix 1 mm longis latisque, compresso-contiguis, subsphaerice bullatis, superne in herbario sculpturatis.

DUTCH NEW GUINEA, Lake Habbema, altitude 3,225 meters, "covering dry ridge points on open grassland," *Brass No. 9182*, type; *No. 9082*, "Alpine grassland, covering the ground on slopes of well drained Ridges." Also, Morobe district, altitude 9,000 to 10,000 feet, in open grassland, *Clemens 9933.*

Near *G. vulcanica* Blume, but much more scaly than the Java plant, and the main axis strictly undivided. I would not be sure by the descriptions, by Blume, or by Mettenius [2] as to the paleæ of costa; but on such Java specimens as are available it is persistently scaly only near the base, and there and on the rachis far less densely than on *G. squamosissima.*

Brass No. 4314, from Mount Albert Edward, identified by Christensen as "G. vulcanica, unbranched form," is less scaly than the plants here described, more so than those of Java. It seems to me that all New Guinea specimens known represent one species, distinct from that of Java.

2. Genus DICRANOPTERIS Bernhardi

Veinlets more than once-forked; sori of multiple (more than 6 in full fruit) sporangia; rhizome and fronds hairy or naked, not paleate; frond pinnate, or forked at top of stipe, then repeatedly forked in full development, with a pair of "stipules" subtending each forking except last forkings, only the stipules and the ultimate divisions of the frond foliaceous. A small genus if *D. linearis* is broadly construed, a fairly large genus if its many forms are treated as species. Pantropic, a little beyond the Tropic of Cancer, and south to New Zealand; not particularly developed in New Guinea.

Key to the New Guinea species of Dicranopteris.

*a*¹. Segments naked or practically so .... 1. *D. linearis.*
*a*². Segments more or less rusty-felty .... 2. *D. ferruginea.*

1. DICRANOPTERIS LINEARIS (Burm.) Underwood.

Brass 12319, altitude 1,700 meters, naked and glaucous beneath; *No. 8807,* altitude 10 to 100 meters, naked, slightly glaucous, much-branched, segments narrow. The two collections seem specifically distinct.

2. DICRANOPTERIS FERRUGINEA (Blume) Copeland comb. nov.

Mertensia ferruginea BLUME, Enum. (1828).

Brass 8961, 8980, Hollandia, altitude 20 to 100 meters. *Brass 5519,* received as *Gleichenia laevigata,* is essentially like this species as represented in Java. *G. linearis* var. *subferruginea* Hieron.,[3] from German New Guinea, New Ireland, and the Solomon Islands, is described as differing in that its rusty felt is broader and mostly confined to the costulæ.

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[2] Ann. Ludg. Bat. 1 (1863) 46.

[3] Engler's Jahrb. 56 (1920) 209.

3. Genus STICHERUS Presl

Sticherus PRESL, Tent. (1836) 51; CHRISTENSEN in Verdoorn, Man. Pterid. (1938) 530.

Rhizome and frond paleaceous or glabrescent; frond in typical development pinnate or bipinnate, its subsequent division pseudodichotomous, the growth of the terminal bud being suppressed above each node; foliar segments borne on ultimate axes and usually on one to three preceding internodes, nodes without stipulelike appendages; veins once-forked; sori of 1 to 6 (most commonly 4) sporangia. A large genus, throughout the Oriental and American Tropics.

The genus is distinct and easily recognizable, but its name has the least possible sanction. I have resurrected a number of Presl's names for genera founded on accidental or illusory, not to say wholly imaginary characters, always on the basis of a fixed type species. With more misgivings, I do this again, for *Hicriopteris*. But the case for *Sticherus* is weaker. Presl avowedly had seen no specimen, and mistrusted this genus even before its publication.—"Generibus quatuor notis duo alia addidi, quorum posterius a me tantum suspicatur, cum hucusque nullum specimen vidi."[4]—he ignored it later in publishing *Hicriopteris;* his diagnostic character, reticulate venation, is imaginary; and it is ambiguously typified. Two species are cited after the diagnosis, of which the first is *S. laevigatus* (*Mertensia laevigata* Willd.) ; therefore this specimen may be accepted as the type. But the other species is a *Dicranopteris,* and this happens to be the one singled out in the diagnosis as having reticulate veins. I adopt this name under the circumstances because the genus has never received another, and because Christensen precedes me in its adoption.

The ramification of the frond of the Gleicheniaceæ is altogether peculiar, only *Lygodium* having some resemblance to it. The application to this leaf of terms having a definite meaning as applied to the leaves and to the stems of other plants has resulted in confusion, and in great difficulty in the interpretation of descriptions. The fronds have commonly been said to be dichotomous; but, writing accurately, they are pseudodichotomous. The bud above the apex of an internode (here we use a term usually applied to stems), representing the continuation of the axis, is suppressed, and at its sides develop a pair of axes, which are really (sub-) terminal pinnæ.

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[4] Tentamen (1836) 47.

To apply to the frond plan usual in *Sticherus,* Diels[5] invented the section name *Holopterygium,* one of four sections of his *Gleichenia.* Later I added a fifth section, *Protogleichenia,* supposed to be characterized by the continued development of a series of these buds, producing a typically pinnate, or eventually bipinnate frond. Actually, of Diels's sections, *Diplopterygium* is a natural group of species, the genus *Hicriopteris; Heteropterygium* is also a natural group, a part of the genus *Dicranopteris; Acropterygium* is not such a group, but represents a frond plan found in *Gleichenia, Dicranopteris,* and *Sticherus.* And my *Protogleichenia,* as distinguished from *Holopterygium,* does not represent a group of species at all; it is a development of which very many species are capable, of which *Holopterygium* is merely an arrested state, apparently too common in herbaria, where the full development of large fronds is likely not to be shown.

At least in the Oriental Tropics, *Sticherus* in full development has bipinnate fronds. After the development of several pairs of pinnæ, and one or a few pairs of pinnules on each of them, the terminal buds cease to develop, and a series of pseudodichotomies follows. According to its degree of individual development, the frond may represent *Holopterygium* and not appear pinnate at all, or it may be once- to thrice-pinnate, and the branches may then be pseudodichotomous (strictly, still pinnate) once to as many as five times. I have confidently identified as *S. habbemensis,* presently to be described, fronds without any rachis, forked at the top of the stipe and only once more (these plants dwarfed, not juvenile), and others more typically developed, with axial, secondary, and tertiary rachises, followed by forkings. Describing species capable of such varied development, such words as pinnule are meaningless, and their use, unless they are defined for this application, is merely confusing. If I have misconstrued some published species, this is my apology, that I do not understand the terms of the descriptions.

At the end of the series of divisions, few or many, of the frond, we find uniformity. The paired axes springing from the last forking are foliose, pectinate. I term their divisions seg-

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[5] Pflanzenfamilien 1 4 (1902) 333.

ments; in the descriptions they have been called variously,—segments, laciniæ, pinnules, and lobes. They are linear in most species of *Sticherus*. The axis of a segment is the costule. It bears the veins, which are uniformly once-forked in *Sticherus*. The sori are dorsal on the acroscopic veinlet, round (punctiform), small, and exindusiate. In the other genera of the family segments are borne only on the ultimate axes of the frond. In *Sticherus* they are usually produced below the last forking, most commonly on two internodes, as well as above the last node.

Key to the New Guinea species of Sticherus.

a^1. Segments ovate or broader.
  b^1. Segments under 1 cm long........ 1. *S. bolanicus.*
  b^2. Segments 2 cm long........ 2. *G. monticola.*
a^2. Segments narrow, commonly linear.
  b^1. Segments naked or soon glabrescent.
    c^1. Height under 60 cm, branches suberect........ 3. *S. erectus.*
    c^2. Normally larger, branches divaricate.
      d^1. Segments green beneath........ 4. *S. laevigatus.*
      d^2. Segments glaucous beneath........ 5. *S. hirtus.*
  b^2. Segments setulose, at least on costules.
    c^1. Sporangia slightly impressed........ 6. *G. Warburgii.*
    c^2. Sori superficial.
      d^1. Rachises with dense indument........ 7. *S. caudatus.*
      d^2. Rachises paleate or glabrescent.
        e^1. Segments green beneath........ 4. *S. laevigatus.*
        e^2. Segments more or less glaucous.
          f^1. Frond papyraceous .... 5. *S. hirtus.*
          f^2. Frond coriaceous .... 8. *S. habbemensis.*
a^3. Costules paleate beneath.
  b^1. Segments somewhat deflexed........ 9. *S. reflexipinnulus.*
  b^2. Segments horizontal or ascending.
    c^1. Segments confined to ultimate branches.
      d^1. Subcoriaceous, segments 13 mm long........ 10. *S. pulcher.*
      d^2. Coriaceous, segments 25 mm long........ 11. *S. pseudoscandens.*
    c^2. Segments present on upper internodes.
      d^1. Segments not over 2 mm wide.
        e^1. Veins very salient beneath........ 12. *S. venosus.*
        e^2. Veins merely evident .... 13. *S. lamianus.*
      d^2. Segments 3 mm wide or wider.
        e^1. Paleæ on ultimate axes 3 mm long........ 14. *S. vestitus.*
        e^2. Paleæ shorter or deciduous........ 15. *S. Brassii.*

1. STICHERUS BOLANICUS (Ros.) Copeland comb. nov.

Gleichenia bolanica ROSENSTOCK, Fedde's Repert. 12 (1913) 16.
Gleichenia subulata VAN ALDERWERELT VAN ROSENBURGH, Nova Guinea 14 (1924) 23.

Brass Nos. 9044, 9626, 9655, 10123, altitude 3,225 to 3,700 meters, in forest and in grass. Also, *Nos. 4387, 4633,* Central Division.[6] The type is from Bolan, altitude 3,400 to 3,800 meters, represented in Herb. Univ. Calif. by a fragment and by the author's tracing.

G. subulata seems by its description to differ in no respect from the varying specimens in hand; it is from "foot of Doorman Summit," altitude 3,250 meters.

2. GLEICHENIA MONTICOLA Ridley.

Collected at the same altitude and in the same region, this appears to differ from *S. bolanicus* only in having ovate segments 2 cm long.

3. STICHERUS ERECTUS (C. Chr.) Copeland comb. nov.

Gleichenia erecta C. CHRISTENSEN, Brittonia 2 (1937) 269.

Brass 4591, 4190, Wharton range, Central Division, altitude 2,840 meters, in open grassland. I mistrust a dwarf species, but this can hardly be a stunted form of *S. hirtus.* Its firmer texture could be correlated with dwarfing, but the paleæ of its axes are uniformly more entire, and the segments are relatively long.

4. STICHERUS LAEVIGATUS (Willd.) Presl.

Long reported from New Guinea; but I have no specimens which match well those from Java.

5. STICHERUS HIRTUS (Blume) Copeland comb. nov.

Gleichenia hirta BLUME, Enum. (1828) 250.
Gleichenia dolosa COPELAND, Perkins' Fragmenta 3 (1905) 193, *pl. 4 C.*
Gleichenia amboinensis VAN ANDERWERELT VAN ROSENBURGH, Bull. Dept. Agr. Ind. Néerl. 18 (1908) 3.
Gleichenia ornamentalis ROSENSTOCK, Nova Guinea 8 (1912) 715.
Gleichenia candida ROSENSTOCK, Fedde's Repert. 5 (1908) 33.

Brass 12468, altitude 2,150 meters, "the principal species in the fern cover on a land slip in the mossy forest," the segments perfectly naked. *King 188,* Goodenough Bay, altitude 1,200 meters, segments strongly but deciduously white-setose beneath. *Schlechter 19842,* Kaiser Wilhemsland, altitude 900 meters, very slightly setose beneath, and now without paleæ on the ultimate axes. *Werner, Ros. Fil. novog. exsicc. 44,* Mount Gelu, altitude 1,700 meters, type collection of *G. candida,* perfectly naked and very glaucous beneath. *Werner s. n.,* received from Rosenstock as *G. candida* Ros. *forma,* typical *S. hirtus,* with deciduous, linear, strongly ciliate paleæ on the axes. *Carr 14572,*

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[6] Christensen, Brittonia 2 (1937) 270.

Beridi, altitude 6,000 feet, *"Gleichenia dolosa* var. *virescens* Hieron.," typical but not very glaucous. *Brass 4924,* Mount Tafa, Central Division, altitude 2,400 meters; Christensen[7] would hold this, as *G. amboinensis,* distinct from *S. hirtus,* but I can see no difference from forms of the latter. Knowing this fern well in the field, and being familiar with its variability in single thickets, I include in it extreme forms which I would be likely to describe as distinct species if I knew them only by the extremes in the herbarium.

6. GLEICHENIA WARBURGII Christ.

Reported in New Guinea by v. A. v. Rosenburgh on the basis of *Lam 1396,* Doorman river, altitude 200 meters. I have this specimen, and do not know the species more authentically. Quite surely the same is *Werner, Ros. Fil. novog. exsicc. 54,* from Mount Gelu, altitude 1,000 meters, received as *G. laevigata* var. *bracteata* (Bl.), a name of which I do not know the origin.

7. STICHERUS CAUDATUS Copeland sp. nov. Plate 2.

Rhizomate 1 cm crasso, paleis atrocastaneis linearibus 6 mm longis, rigidis, subintegris vestito; stipite 45 cm alto, 5 mm crasso, fusco, deorsum glabrato et verruculoso, sursum indumento appresso-flocculoso tum demum deciduo vestito; fronde pinnata, pinnis bis furcatis, rhachibus indumento cinereo vestitis; gemmis dormantibus paleis castaneis 1.5 ad 2 mm longis basibus ciliatis apicibus setiformi-protractis vestitis; costis superne pilis albis crinitis vestitis, sursum glabrioribus, inferne et setis albis contortis et paleis parvis castaneis basibus ovatis ciliatis apicibus setiformibus longis ornatis; ramis ultimis 15 ad 20 cm longis, 3 ad 4 cm latis, anguste caudatis, internodio uno tantum plerumque segmentifero; segmentis adscendenti-patentibus, ob margines revolutos vix 2 mm latis, coriaceis, costulis inferne pilis albidis crinitis ornatis; soris medialibus, confluentibus, sporangiis circa 4.

DUTCH NEW GUINEA, *Brass No. 12466;* "One clump 0.75 m high, on an open rock side at 2,150 m. 18 Km. SW. of Bernhard Camp, Idenburg River."

Well characterized by its various pubescence, particularly by the dark-brown component of it. *Gleichenia caudata* Copeland, of Fiji, is a *Dicranopteris.*

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[7] Christensen, Brittonia 2 (1937) 270.

8. STICHERUS HABBEMENSIS Copeland sp. nov. Plate 3.

Rhizomate 3 ad 4 mm crasso, paleis sparsis fuscis 1.5 mm longis anguste ovatis tum demum deciduis et tubercula sat magna reliquentibus vestito; stipite usque ad 80 cm alto, 3 mm crasso, castaneo, basi paleaceo alibi glabro; fronde grande, bis vel ter pinnata, deinde bis furcata, gemmis dormantibus dense, rhachibus inferioribus sparse, superioribus non dense paleis 2 mm longis lanceolatis castaneis pallide ciliatis vestitis; ramo ultimo usque ad 30 cm longo, penultimo 4 ad 6 cm longo foliaceo, proximo 2 ad 3 cm longo interdum foliaceo; segmentis horizontalibus, majoribus 2 cm longis, 2.5 ad 3 mm latis, coriaceis, inferne glaucis, margine plerumque deflexo, costula inferne et squamulis omnino dissectis et fibrillis vix persistentibus vestita, venis marginibusque setulis caducis adspersis; soris superficialibus, sporangiis 4 vel 5.

DUTCH NEW GUINEA, *Brass No. 10569,* type, 9 kilometers northeast of Lake Habbema, altitude 2,800 meters, "plentiful on wet, clayey soil of landslips;" *No. 11588,* Bele River, altitude 2,200 meters, "abundant in open second growths; erect or shortly scrambling;" *No. 9100,* Lake Habbema, altitude 3,225 meters, "abundant in moist gullies," a depauperate form, total height 20 to 80 cm, with one pair of once-forked pinnæ.

9. STICHERUS REFLEXIPINNULUS (C. Chr.) Copeland comb. nov.

Gleichenia reflexipinnula C. CHRISTENSEN, Brittonia 2 (1937) 271.

Brass 4847, Mount Tafa, Central Division, altitude 2,700 meters.

10. STICHERUS PULCHER Copeland sp. nov. Plate 4.

Fronde bipinnata; rhachi 1.5 mm crassa, castanea, paleis minutis perpaucis adspersa aliter (sub oculo nudo omnino) glabra; rhachibus secundariis gracilioribus; pinnulis infimis pectinatis, sequentibus furcatis, rhachibus tertiariis circa 2 cm longis segmentis carentibus, gemmis dormantibus minutis, ramis ultimis solummodo segmentiferis, usque ad 20 cm longis et 25 mm latis, vix ad costam pectinatis, superne glabris, costa inferne ad latera paleis inconspicuis vix 1 mm longis attenuatis ciliatis vestita; segmentis fere horizontalibus, circa 3 mm latis, apice rotundatis; subcoriaceis costulis paleis minutis sublaceris ferrugineis subdeciduis ornatis, venulis minute stellato-fibrillosis deinde glabrescentibus; soris medialibus, parvis, sporangiis plerumque 4, rarius 3 vel 5.

DUTCH NEW GUINEA, *Brass No. 12351,* "Scrambling in mossy forest seral growth at 1650 m, glaucous beneath; 15 Km SW. of Bernhard Camp, Idenburg River."

In the specimen the glaucousness is inconspicuous. The most conspicuous character of the species is the restriction of the segments to the ultimate axes. It is also remarkable for its very slender rachises.

11. STICHERUS PSEUDOSCANDENS (v.A.v.R.) Copeland comb. nov.

Gleichenia pseudoscandens VAN ALDERWERELT VAN ROSENBURGH, Nova Guinea 14 (1924) 23.

Doorman Top, altitude 2,480 meters, *Lam 1935,* in Herb. Univ. Calif. Darker, more firm, larger, and more glabrescent than *S. pulcher.*

12. STICHERUS VENOSUS Copeland sp. nov. Plate 5.

Rhizomate stipiteque 3 mm crassis, castaneis, glabrescentibus; fronde pinnata vel bipinnata, deinde ter vel quater furcata, rhachibus non segmentiferis glabrescentibus, nodis inferioribus stipulis parvis dissectis donatis, gemmis dormantibus plerisque obsoletis, ramo ultimo et internodiis 1 ad 3 segmentiferis, ramo ultimo usque ad 25 cm longo, 3 cm lato; costis paleis ovatis 0.6 mm longis sparsis mox disruptis vestitis deinde glabrescentibus; segmentis horizontalibus, 2 mm latis, apice rotundatis, margine deflexis, chartaceis; costulis inferne paleis pallidis ovatis demum fimbriatis densis et interdum complexis vestitis; venis inferne insigniter praestantibus; soris medialibus, sporangiis circa 4.

DUTCH NEW GUINEA, *Brass No. 12348,* type; "Frequent in open places in the mossy forest at 1650 m, scrambling to 2–3 m; glaucous beneath; 15 Km. SW. of Bernhard Camp, Idenburg River;" *No. 12467,* "Associated with No. 12468 (*S. hirtus*) on a landslip in the mossy forest at 2150 m up to 1 m high and of weak habit." Here also *Brass 4797,* from Vanapa Valley, Central Division, distributed as *G. laevigata.*

Conspicuously characterized by the salient venation. *G. laevigata* has fine veins and much less scaly costulæ. Still other distinct species from Borneo and the Philippines bear this name in herbaria.

13. STICHERUS LAMIANUS Copeland sp. nov. Plate 6.

Stipite ad basi 9 mm crasso, paleis rufo-castaneis usque ad 12 mm longis lanceolatis valde attenuatis subintegris immerso, sursum glabrescente, purpureo-fusco, verruculoso; fronde bipinnata, pinnulis quater furcatis, ramo ultimo et internodiis dos segmenta gerentibus, gemmis dormantibus parvis vel obsoletis; ramis ultimis 20 ad 25 cm longis, 2 ad 2.5 cm latis, vix ad costas pectinatis, costa inferne paleis lanceolatis, acuminatis, 1 ad 1.5 mm longis cinereis plus minusve araneoso-marginatis ornata, apicem versus glabra; segmentis fere horizontalibus, 2 mm latis, apice rotundatis, margine leviter deflexis, papyraceo-coriaceis, inferne subglaucis, costulis paleis albidis araneoso-dissectis ornatis; soris medialibus, sporangiis 3 vel 4.

DUTCH NEW GUINEA, *Brass No. 11455,* type; "One clump in open undergrowth under oaks; erect or suberect to 2 meters. Bele River, 18 Km NE. of Lake Habbema, alt. 2350 m." Also, *Lam No. 1945,* rug near Doorman Top, altitude 2,400 meters, received as *G. ornamentalis* Rosenst. var. *lanuginosa,* det. v. A. v. R.

14. STICHERUS VESTITUS (Blume) Copeland comb. nov.

Gleichenia vestita BLUME, Enum. (1928) 249.

Reported here by Ridley;[8] I have seen no New Guinea specimen.

15. STICHERUS BRASSII (C. Chr.) Copeland comb. nov.

Gleichenia Brassii C. CHRISTENSEN, Brittonia 2 (1937) 271.

Brass 4922, Mount Tafa, Central Division, altitude 2,400 meters. Somewhat like *S. pseudoscandens* in aspect, but with light-brown scales on the dormant buds, and segments on the highest internodes.

4. Genus HICRIOPTERIS Presl

Hicriopteris PRESL, Epim. (1849) 26.

Ultimate main divisions of the frond paired and bipinnate, segments borne only on their numerous divisions; like *Sticherus* in paleæ, venation, and sori. A small genus of very large ferns, of the Tropics and northward to Japan.

This group of species is evidently a natural one, and is exceptionally easy to recognize; therefore, to leave *Sticherus* smaller and more uniform, it is expedient to regard *Hicriopteris* as a distinct genus. I adopt Presl's name on the supposition that his one species, *H. speciosa,* is really the same he described one page previously as *Mertensia gigantea,* and that his distinctive characters, twice-forked veins with marginal anastomoses, were illusions. It is my practice to identify genera by their types. In this instance I would like better to use Hasskarl's well-authenticated name, *Mesosorus,* typified by the same species, *Gleichenia*

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[8] Trans. Linn. Soc. Bot. II 9 (1916) 252.

gigantea Wallich: Hooker; but I would have then to expect every species presently to be renamed.

Following the use of the term, in *Sticherus*, I call the midvein of a segment the costule, and the axis from which these spring the costæ; the costæ spring from the ultimate rachis. Peculiarly to this genus, I call that division of the frond a pinna which has the ultimate rachis as its axis; its divisions are of course pinnules, the axes of which are the costæ.

Key to the New Guinea species of Hicriopteris.

a ¹. Costæ strongly scaly.
  b ¹. Costæ also densely tomentose.................................. 1. *H. novoguineensis.*
  b ². Costæ slightly tomentose under scales......................... 2. *H. arachnoides.*
a ². Costæ slightly and minutely scaly.................................. 3. *H. astrotricha.*

1. HICRIOPTERIS NOVOGUINEENSIS (Brause) Copeland comb. nov.

Gleichenia novoguineensis BRAUSE, Engler's Jahrb. 56 (1920) 210.

Described from German New Guinea; type, *Ledermann 12744*. *Brass 4960*, from Mount Tafa, Central Division, is identified as this species by Christensen.

2. HICRIOPTERIS ARACHNOIDES (Hasskarl) Copeland comb. nov.

Mesosorus arachnoides HASSKARL, Obs. Bot. (1856) 6.

Brass 12461, altitude 2,150 meters, 1 to 1.5 meters tall, conforms well with the Javan plant, already reported in New Guinea by Ridley. *Gleichenia bullata* Mett. is a distinct Bornean species.

3. HICRIOPTERIS ASTROTRICHA Copeland sp. nov.

Rhachi axiale laete brunnea, glabrata vel inferne hic illuc tomento fusco appresso maculata, 8 mm crassa, nodis superne paleis 2 ad 10 mm longis, linearibus, castaneis atrocastaneo-marginatis breviter ciliatis immersis; pinna 80 cm longa, acuta, sessile, pinnulis infimis reductis stipulas simulantibus; rhachi indumento atrofusco e paleis et amorphis et stellatis et rarius protractis composito vestita; pinnulis plerisque 10 ad 11 cm longis, basi 25 ad 28 mm latis, subsessilibus, costis superne indumento huic rhacheos simile sed paleis protractis (etsi minutis) crebrioribus vestita, inferne apicem versus glabra, alibi nisi prope rhachin glabrescente; segmentis circa 3 mm latis, infimis basi contractis, sequentibus omnino adnatis, caeteris anguste connexis, apice rotundatis, subcoriaceis, superne saturate viridibus glabris, inferne fusco-viridibus, costulis mox glabratis, venis praestantibus ubique paleis minutis castaneis stellato-dissectis ornatis.

DUTCH NEW GUINEA, *Brass No. 12129,* "Occasional under a broken canopy in the mossy forest at 1800 m, scrambling to a height of 4–5 m; glaucous beneath; 15 Km. SW. of Bernhard Camp, Idenburg River." The glaucousness is not evident in the herbarium.

Rosenstock Fil. novog. exsic. n. 33, l. Werner, Kaiser Wilhelmsland, mount Gelu, 1,000 meters, distributed as *Gleichenia longissima* Bl. var. *novoguineensis* Ros. mss., is this species, less brown and more glaucous beneath than the type, and with fewer of the minute stellate squamulæ on the veins. *H. novoguineensis* (Brause) is much more densely scaly, and without the peculiar dark stellate squamulæ on the veins.

ERRATA

Vol. 73, p. 460, insert the following after line 6:

MECODIUM LEVINGEI (Clarke) Copeland comb. nov.

Hymenophyllum Levingei CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 439, *pl. 49, fig. 3.*

CHINA, Yunnan, Lung-pan-la Champutong, altitude 3,000 meters. *C. W. Wang, Fan Mem. Inst. 67117.*

Before seeing this species I hesitated to believe Clarke's description, but find it perfectly accurate. The stipe and lower part of the rachis are hairy, with multicellular hairs, the cells bearing chlorophyll like those of the lamina. Then, following up the rachis, an occasional hair is two cells wide at the base, or for any part of its length, but not to its apex. Then, some are three cells wide, and wider; until, on the upper and minor axes, some of them are lanceolate and some are ovate. In texture they are like the green lamina. By usual definition these are paleæ, but paleæ do not have this structure, and are not supposed to occur in Hymenophyllaceæ.

The affinity is to *Mecodium.* It is aberrant, there or anywhere else in the family. But a genus which already contains *M. Reinwardtii, M. exsertum,* and *M. scabrum* can find room for *M. Levingei.* There is no evident near affinity to *Myriodon, Buesia,* or *Meringium* (*Ptychophyllum*) *plicatum.*

Volume 73, p. 463, insert the following after line 24:

MERINGIUM BRYOPHILUM (C. Chr.) Copeland comb. nov.

Hymenophyllum bryophilum C. CHRISTENSEN, Brittonia 2 (1937) 274.

Distinguished from *M. Foersteri* by being much less hairy, and hardly otherwise. The isotype, *Brass 4262,* in Herb. New

York Bot. Garden, has one frond with all receptacles long-exserted.

Vol. 73, p. 465, insert the following after line 4:

MERINGIUM DENTICULATUM (Sw.) Copeland.

CHINA, Kwangsi, *C. Wang, Sun Yatsen Univ. 40602.*
My first specimen of this species from continental China.

MECODIUM PANICULIFLORUM (Presl) Copeland.

CHINA, Si-Kang, altitude 2,500 meters, *C. W. Wang, Fan Mem. Inst. 65447.*
Reported several times from China, but this is my first specimen.

Vol. 73, p. 467, insert the following after line 37:

CEPHALOMANES SUMATRANUM (v.A.v.R.) Copeland.

Hainan, *S. K. Lau, Sun Yatsen Univ. 28042.*
Previously known from Annam.

VOLUME 74, NO. 2

Pages 153 and 155: *For* Holttumia in the title, in the text, and in the illustration, *read* Holttumiella.
Page 153, line 4 of text: *For* illus, *read* illuc.

ILLUSTRATIONS

[All plates are from photographs by W. C. Mathews of the types in the herbarium of the author.]

PLATE 1. *Gleichenia squamosissima* Copeland sp. nov.
PLATE 2. *Sticherus caudatus* Copeland sp. nov.
PLATE 3. *Sticherus habbemensis* Copeland sp. nov.
PLATE 4. *Sticherus pulcher* Copeland sp. nov.
PLATE 5. *Sticherus venosus* Copeland sp. nov.
PLATE 6. *Sticherus lamianus* Copeland sp. nov.

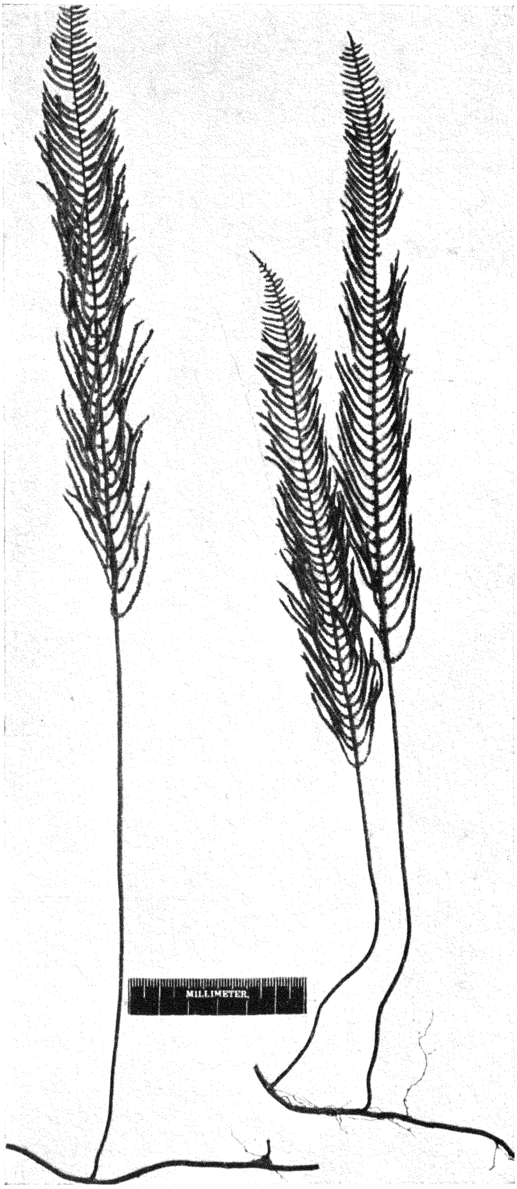

PLATE 1. GLEICHENIA SQUAMOSISSIMA COPELAND SP. NOV.

UNIV. OF MICH.

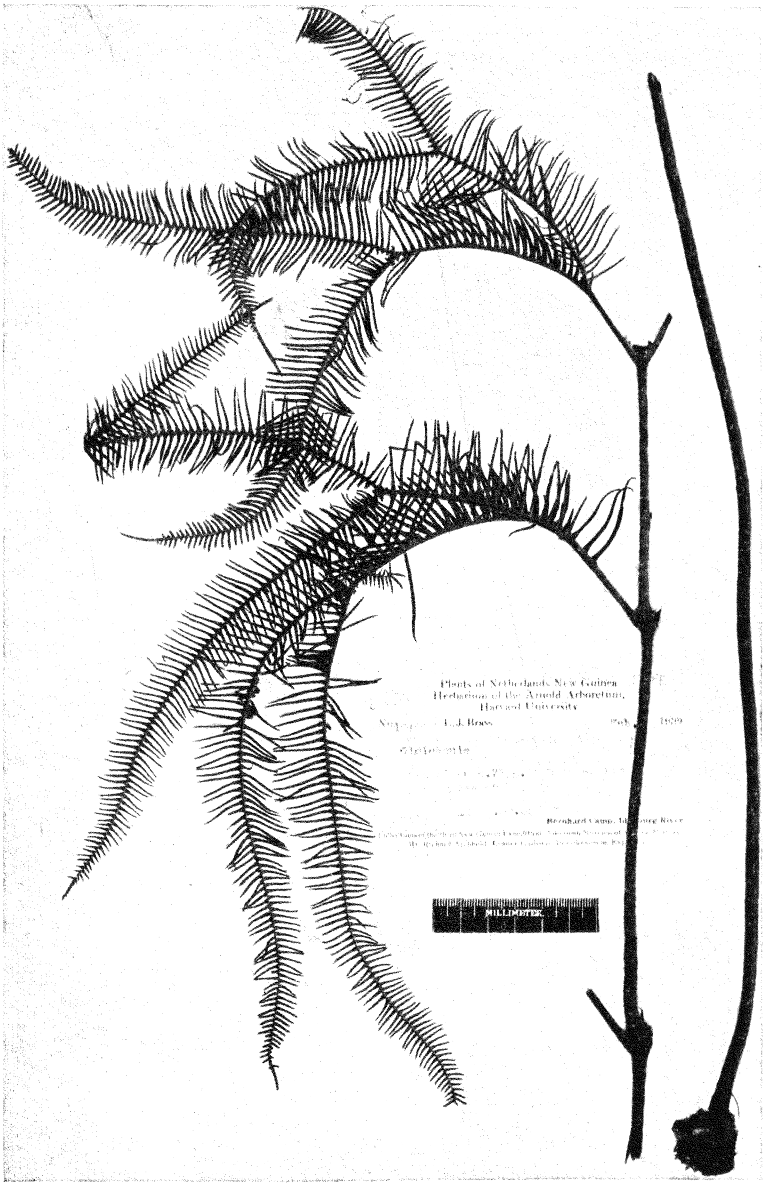
Plants of Netherlands New Guinea
Herbarium of the Arnold Arboretum,
Harvard University
L. J. Brass
1939
Bernhard Camp, Id burg River
MILLIMETER

PLATE 2. STICHERUS CAUDATUS COPELAND SP. NOV.

UNIV. OF MICH.

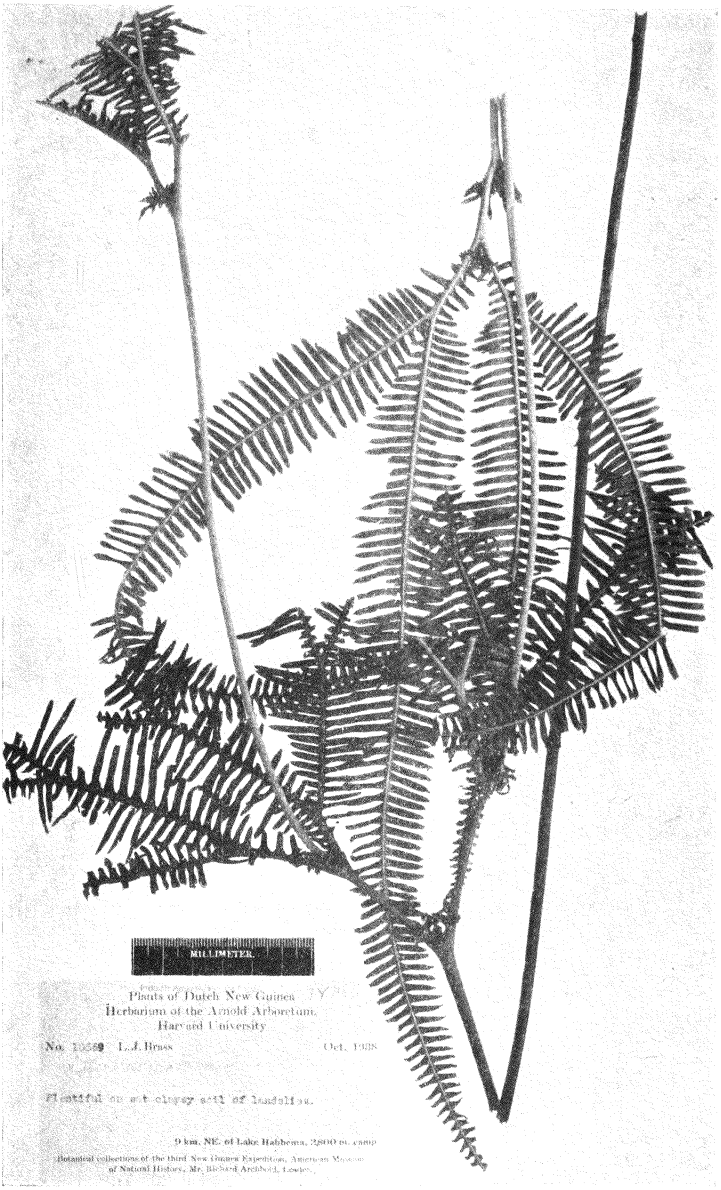
MILLIMETER.
Plants of Dutch New Guinea
Herbarium of the Arnold Arboretum,
Harvard University
No. 10569 L. J. Brass Oct. 1938
Plentiful on wet clayey soil of landslips.
9 km. NE. of Lake Habbema, 2800 m. camp
Botanical collections of the third New Guinea Expedition, American Museum of Natural History, Mr. Richard Archbold, Leader.

PLATE 3. STICHERUS HABBEMENSIS COPELAND SP. NOV.

UNIV. OF MICH.

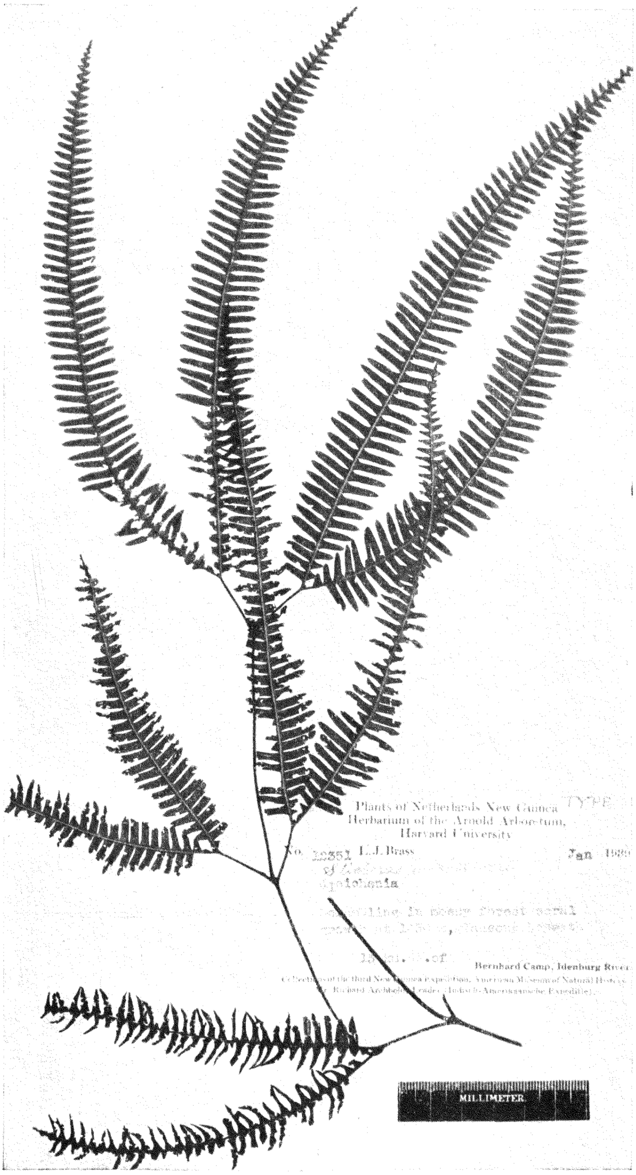
Plants of Netherlands New Guinea
Herbarium of the Arnold Arboretum,
Harvard University
TYPE
L. J. Brass
Jan
Bernhard Camp, Idenburg River
MILLIMETER

PLATE 4. STICHERUS PULCHER COPELAND SP. NOV.

UNIV. OF MICH.

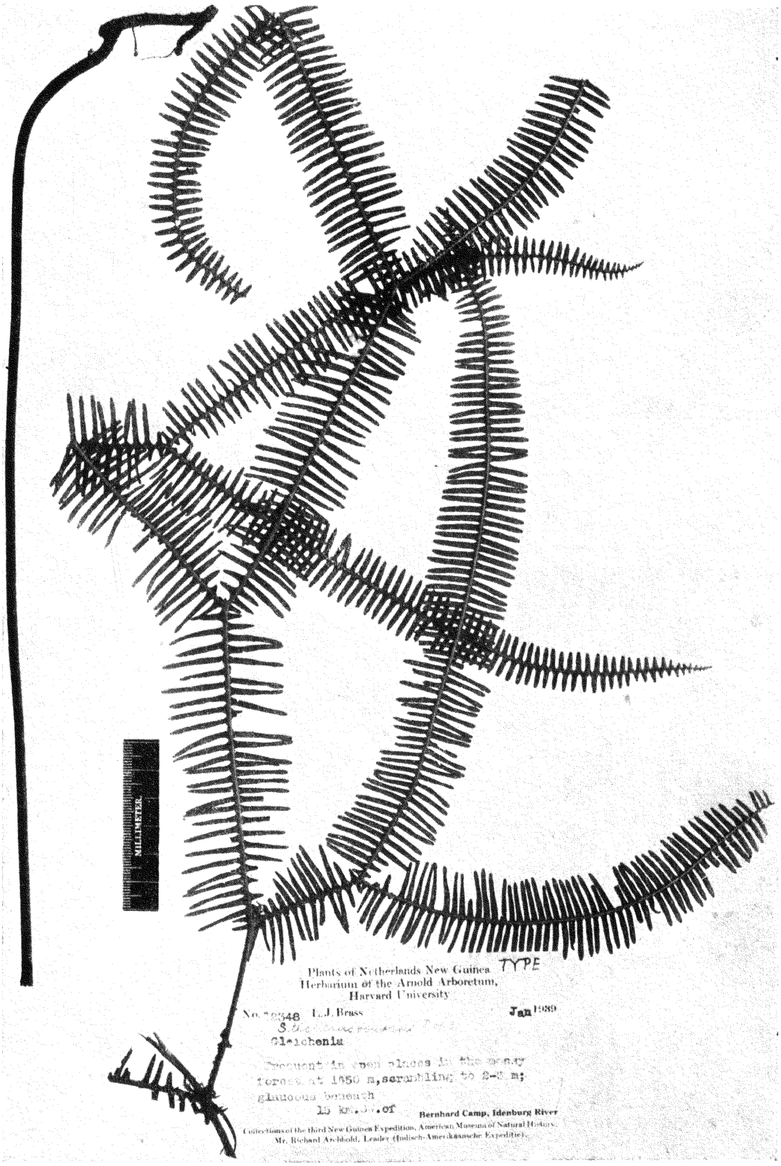
MILLIMETER
TYPE
Plants of Netherlands New Guinea
Herbarium of the Arnold Arboretum,
Harvard University
L. J. Brass
Jan 1939
Gleichenia
forest at 1850 m, scrambling to 2-3 m;
glaucous beneath
Bernhard Camp, Idenburg River
Collections of the third New Guinea Expedition, American Museum of Natural History.
Mr. Richard Archbold, Leader (Indisch-Amerikaansche Expeditie).

PLATE 5. STICHERUS VENOSUS COPELAND SP. NOV.

UNIV. OF MICH.

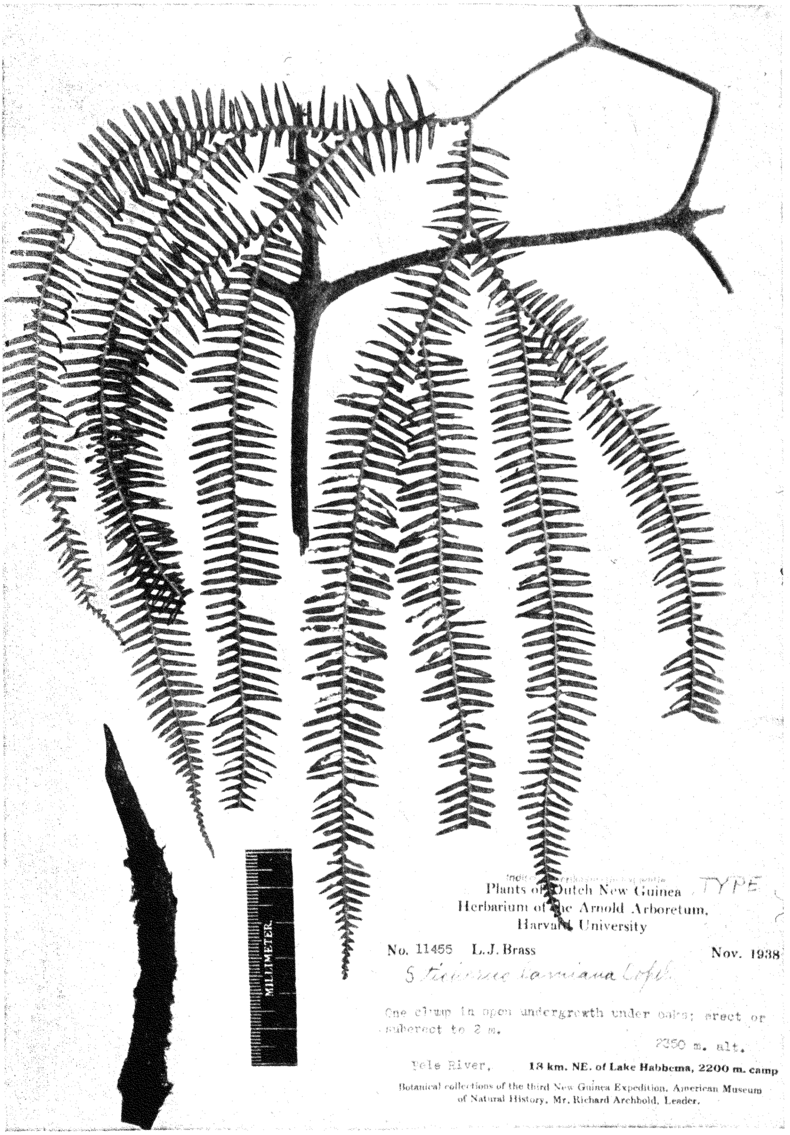
MILLIMETER
Plants of Dutch New Guinea
Herbarium of the Arnold Arboretum,
Harvard University
TYPE
No. 11455 L. J. Brass Nov. 1938
Sticherus lamiana Copel.
One clump in open undergrowth under oaks; erect or subercet to 2 m.
2350 m. alt.
Bele River, 18 km. NE. of Lake Habbema, 2200 m. camp
Botanical collections of the third New Guinea Expedition, American Museum of Natural History, Mr. Richard Archbold, Leader.

PLATE 6. STICHERUS LAMIANUS COPELAND SP. NOV.

UNIV. OF MICH.

TANNIN FROM KERNELS OF GREEN BETEL NUTS

By LUZ BAENS

Of the Bureau of Science, Manila

Although there are a number of tanneries in the Philippines, the annual importation of leather and leather articles amounts to about three million pesos.[1]

For the last few years the possibility of utilizing Philippine vegetable tanning materials for the manufacture of leather[2] has been studied. In the course of this investigation it was found that the kernels of green betel nuts (*Areca catechu* Linn.) contain a considerable amount of tannin which gives a leather of fine natural color.[3] Because of the excellent quality of this leather the investigation of betel-nut tannin has been continued. Recent results are recorded in this paper.

The betel-nut palm (*Areca catechu* Linn.)[4] is known in the Philippines as *boñga, buñga,* or *luyos.* Beccari[5] states that out of the 36 species of *Areca* known to him no less than 10 are very characteristic Philippine palms. A variety of *Areca catechu* (var. *silvatica*) has been found as a forest plant in Palawan. *Areca catechu* (var. *longicarpa*) is also a wild plant in Polillo. These species are probably native Philippine plants.

Areca catechu[6] is a graceful, tall-stemmed palm usually reaching a height of 60 feet; the stem is cylindrical, with a diameter of 5 to 8 inches and ringed distinctively from the base upward by the scars of fallen leaves. The young stem is green, and the old, grayish. The strong roots which grow out above the base maintain the erect position of the palm. When grown under the best conditions it begins to flower in about 4 years.

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[1] One peso equals 50 cents United States currency.

[2] Baens, Luz, and A. P. West, Philip. Journ. Sci. 47 (1932) 467; Baens, Luz, F. M. Yenko, and A. P. West, Philip. Journ. Sci. 55 (1934) 177; Yenko, F. M., and Luz Baens, Philip. Journ. Sci. 61 (1936) 415.

[3] Baens, Luz, F. M. Yenko, and A. P. West, Philip. Journ. Sci. 55 (1934) 177.

[4] Blätter, E., Palms of British India and Ceylon (1926) 47.

[5] The Palms of the Philippine Islands, Philip. Journ. Sci. 14 (1919) 295.

[6] Sands, W. N. Observation on the betel-nut palm (Areca catechu, L.) and betel-nuts. Malayan Agri. Journ. 14 (1926) 202.

According to Grist[7] the plant grows well in places with evenly distributed rainfall. The seeds are first planted in a nursery and transferred after 6 to 18 months.

Stirrup[8] says that the most suitable planting distance is 8 by 8 feet, giving a stand of 680 trees per acre or 1,680 trees per hectare (1 hectare equals 2.47 acres). The average number of nuts in a bunch is 200. A young palm may bear 5 or 6 bunches annually, while an older palm may have only 1 or 2 bunches.

In the Philippines the kernels of the ripe nuts are generally used for chewing. They are usually combined with betel-vine leaf (*Piper betle* Linn.), a little lime, and tobacco. The chewers claim that chewing betel nut prevents decay of the teeth, although it leaves red stains on the enamel.

While there are no regular betel-nut plantations in the Philippines, these trees are widely distributed throughout the country. In some districts they are grown in fairly large numbers. The price of the green and ripe nuts is about the same. Usually it varies from 0.05 to 0.20 peso per 100, depending upon the supply and demand.

The tannin in betel nuts is located almost entirely in the kernel. The outside husk has only traces. As the green nut ripens, the tannin in the kernel decreases. Tests showed that the ripe kernels have only about half as much tannin as those of full-grown green nuts collected from the same tree. The highest tannin content is attained when the kernel is just about reaching maturity while the outside husk is still grass green.

Analyses of the kernels of full-grown green betel nuts from different districts showed that the tannin in them varied from 12.98 to 26.89 per cent. The high percentage suggested them as a promising source of commercial tanning material.

A composite sample of dried kernels of green betel nuts from a single tree gave the analysis recorded in Table 1. This full-grown fruit, which was about 4 months old, contained 20.16 per cent tannin. Betel-nut tannin compares favorably with other commercial tanning materials.

TABLE 1.—*Analysis of dried kernels from green betel nuts.*

Constituents.	Per cent.
Total solids	32.19
Soluble solids	29.67
Nontannins	9.51
Tannins	20.16

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[7] The betel nut industry. Malayan Agri. Journ. 14 (1926) 219.

[8] The betel nut industry in the Muar Distinct, Johore. Federated Malay States Agri. Bull. 5 (1917–1918) 189.

Another composite sample of full-grown green betel nuts was obtained from Pagsanjan, Laguna Province, and used in preparing solid tanning extracts as follows: The nuts were opened and the kernels cut into small pieces. The material was extracted several times with water at 70°C. The combined liquid extracts were evaporated under reduced pressure at 70°C. until the concentration of the liquid was such that it solidified upon cooling.

Data on the extraction are:

Number of nuts used	10,073
Weight of nuts	366 kilograms
Weight of moist kernels	124.75 kilograms
Moisture in kernels	75.51 kilograms
Weight of dry kernels	49.24 kilograms
Weight of solid extract	15.56 kilograms
Extract in whole nuts	4.25 per cent
Extract in dry kernels	31.60 per cent

Assuming that a hectare can be planted with 1,680 trees, and that each tree gives annually an average of 3 bunches containing 200 nuts each, the yield of solid extract may be estimated as follows:

1 palm gives 600 nuts
1 hectare (1,680 palms) should bear 1,008,000 nuts
10,073 nuts yield 15.56 kilograms solid extract
1 hectare (1,008,000 nuts) should yield 1,556 kilograms of solid extract

In preparing the tanning extract the solution was evaporated until it contained only a small amount of moisture. When placed in a vacuum oven the bottom portion (sample B) solidified. The top portion (sample A) separated out as a coarse powder. About four-fifths of the entire extract was contained in sample B.

Analysis of the betel-nut extract described above is compared with that of the extract from Philippine bakauan bark (cutch) in Table 2. Analyses[9] of imported tanning materials (oak, hemlock, chestnut, and myrobalan) are also included.

The results (Table 2) show that betel-nut extract compares favorably with cutch and also with imported commercial tanning materials (oak, hemlock, chestnut, myrobalan).

Goatskins and sheepskins tanned with betel-nut extract in our laboratory have a fine, smooth grain and a natural light color.

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[9] Baens, Luz, Leon G. Alejo, and V. G. Lava. Philip. Journ. Sci. 72 (1940) 451.

TABLE 2.—*Analysis of betel-nut extract and other tanning materials.*

Constituent.	Betel-nut extract.		Cutch.	Oak.	Hemlock.	Chestnut.	Myrobalan.
	A.	B.					
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Total solids	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Soluble solids	94.50	95.41	99.18	94.18	94.74	97.43	88.56
Insoluble solids (by difference)	5.50	4.59	0.82	5.82	5.26	2.57	11.44
Nontans	29.16	28.45	23.86	40.77	30.92	29.85	32.97
Tannins (by difference)	65.34	66.96	75.32	53.41	63.82	67.58	55.59
Ash	5.03		5.20				
Moisture content before calculating on a moisture-free basis	14.91	13.91	23.51	12.18	10.10	11.61	19.05

NOTE.—Results calculated on a moisture-free basis.

Tests on the betel-nut extract were made at the Philippine Cutch Corporation (Zamboanga) before the company was transferred to Borneo. Mr. Geo. A. Kerr, vice president and general manager of the company, said that sheepskin leather made with our betel-nut extract was about the finest light leather tannage he had ever seen. He also stated that he had treated some extracts chemically to produce a similar color, but he did not find any that gave such a fine natural color as that of the betel nut. He further assured us that this extract had a bright future for extensive use in tanning light leather from goat skins and sheepskins because of the fine natural color. Bleaching or any chemical treatment before dyeing is not necessary when betel-nut extract is used. For bookbinding and fine light leather, he considered this extract an ideal vegetable tannin material.

SUMMARY

Betel-nut palms are grown throughout the Philippines. They bear fruits about 4 years after planting. The fruit matures usually in about 6 months.

The tannin in betel nuts is located almost entirely in the kernel. The outside husk has only traces of tannin. As the green nut ripens the tannin in the kernel decreases. Ripe kernels have only about as much tannin as those of full-grown green nuts collected from the same tree. The highest tannin content is attained when the kernel is just about reaching maturity and while the outside husk is still grass green.

The kernels of full-grown green betel nuts from different trees gave a tannin content that varied from 12.98 to 26.89 per cent.

When betel-nut trees are grown 8 feet apart in plantations there are 1,680 trees to the hectare. Our results show that 1,556 kilograms of solid betel-nut extract may be produced from one hectare (1,680 trees).

The solid betel-nut extract contained 65.34 to 66.96 per cent of tannin. In composition it compares favorably with cutch (extract from bakauan) and also with foreign extracts (oak, chestnut, hemlock, and myrobalan). For light leather tannage the quality is excellent.

Goatskins and sheepskins tanned with betel-nut extract have an unusually smooth grain and a fine natural color.

The investigation indicates that the production of tanning extract from betel nuts grown in plantations has promising prospects.

ACKNOWLEDGMENT

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STUDIES ON THE BIOLOGY OF THE AMOY AMPHIOXUS BRANCHIOSTOMA BELCHERI GRAY

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FIVE PLATES AND EIGHTEEN TEXT FIGURES

Because of the present war waged by the Japanese in China the National University of Amoy, originally located near the famous amphioxus grounds in the port of Amoy, has been moved inland. The studies on the biology of the Amoy amphioxus, which had been carried on for a number of years, were consequently interrupted. It seems advisable, at this moment of uncertainty, to publish the available data so far gathered.

The systematic position of the Amoy amphioxus has already been carefully ascertained by several authors, (3, 42) all of whom gave it the specific name of *Branchiostoma belcheri* Gray, although there may be slight differences in the minute characters of the various specimens studied.

Recently Tchang and Koo (42) collected some amphioxus from Tsingtao, which was described as a new variety of *B. belcheri*, found in Amoy and its vicinity. Since it usually, but not always, has 2 or 3 more myotomes in the preatriporal region, this amphioxus is referable to *Branchiostoma belcheri* var. *tsingtauensis*.

The writer is indebted to Dr. T. Y. Chen, the Director of the Marine Biological Station, and the Head of the Department of Biology, the National University of Amoy, under whom a part of the present work was carried on, and also for his continuous encouragement and valuable criticisms during this study; to Dr. H. T. Chen, the Head of the Department of Biology, Lingnan University, Canton, for his valuable suggestions and criticisms, and for his kindness in reading the entire manuscript. The writer wishes also to express his thanks to Mr. Chih-tuh Chen, formerly technician of the Biological Supply Service, University of Amoy, for his assistance in measuring about 100,000 individual specimens for the study of the rate of growth of this amphioxus.

HISTORY

Apparently the first man to have secured specimens of *Amphioxus* for systematic study was a German zoologist, P. S. Pallas, who received a single example from his friend who collected it from the Cornwall Coast. Pallas named this animal *Limax lanceolatus,* believing that the specimen was an elongated *Limax* of the phylum Mollusca. In 1834 an Italian zoologist, G. Costa, collected amphioxus from the Posilippo Coast. He named it *Branchiostoma lubricum,* believing it to be related to the cyclostomes (Cyclostomata). In 1836 an English zoologist, W. Yarrell, renamed it *Amphioxus lanceolatus.* After these incidents numerous articles about amphioxus appeared in various journals and publications.

According to Chen (5) the history of the Amoy amphioxus may be briefly given as follows:

In the Tan Dynasty (616–905 A. D.) Han Yü killed many crocodiles at Chao Chow, Kwantung Province, but one of the wounded escaped to Amoy. After some time it died, and "maggots" from the carcass gradually changed to amphioxus. The amphioxus was, therefore, called "crocodile fish" or "crocodile maggot" by some people. This is the oldest record of amphioxus, and it indicates that the Amoy amphioxus had been known for more than one thousand years.

In the Sung Dynasty (960–1276 A. D.) Chu Hsi came to this district and "killed" the "Crocodile" Island in the front of Liuwutien with his "red pen." A piece of stone from that Island which was dropped into the sea was believed to have given rise to the numerous specimens of amphioxus borne in the sand. This information suggests that the Amoy amphioxus was known at least five hundred years ago.

At the end of the Ming Dynasty (1368–1643 A. D.) Chen Cheng-kung came to Amoy, but found insufficient food for his navy. One of the things he did was to pour several bowls of cooked rice into the sea, after which numerous individuals of amphioxus appeared floating on the water. These animals were then less used as food by Chen and his navy, hence the name of "rice fish" for amphioxus. If this is true, the history of amphioxus extends back more than three hundred years.

Besides the "crocodile fish" and "rice fish" described above for amphioxus in Chinese, there are still five other names commonly used by the natives in Amoy and its vicinity, namely: *'Wen Tsu Yü', 'Pien Tan Yü', 'Yin Chang Yü',* and *'Wen Shen Yü'.*

'Wen Tsu Yü' is probably derived from the name of a small marine fish mentioned in ancient Chinese literature, 'Yu Pien.' This name is commonly used at Chipbee and in Tung An districts.

'Pien Tan Yü' means 'carrying-pole fish,' since the amphioxus resembles the carrying pole used in Amoy, which is a stick of wood, broad in the middle and narrow at both ends.

'Yin Chien Yü' means 'silver-spear fish,' so called because the amphioxus is very much like the silver-colored Chinese spear blade, which is probably the best name for amphioxus in Chinese.

'Ying Chang Yü' is derived from *'Yin Chien Yü.'*

'Wen Shen Yü' is the commonest name in Chinese, and means literary-composition fish.' The derivation of *'Wen Shen'* is quite obscure. It can explained in four different ways. Firstly, *'Wen Shen'* is the name of a star. Secondly, *'Wen Shen'* is the name of the God of Literature in Chinese mythology. It is said that the God of Literature rode on the back of a crocodile, which later died and the body gradually was decomposed into the "fish of the God of Literature.' Lastly, the sound of *'Wen Shen'* is closely related to *'Yin Chien.'*

In spite of the above-mentioned records the Amoy amphioxus was not known to the scientific world until Prof. S. F. Light, formerly Professor of Biology of the National University of Amoy, published his amphioxus fisheries in Science and in The China Journal in 1923. He pointed out the inexhaustible supply of amphioxus near the University of Amoy, and described in general the methods of fishing amphioxus. After this announcement numerous orders were sent to the University for these important and rare animals. Many people also came to Amoy to visit the amphioxus fishing grounds.

In 1929 Rathbun described some crabs collected from the amphioxus grounds. In 1930 C. Ping mentioned the Amoy amphioxus in his paper and called it *Branchiostoma lanceolatus.* In 1931 T. Y. Chen described a hermaphroditic amphioxus from Amoy. In the same year, C. D. Reeves published notes on the ecology of this animal as well as on the nature of its atrium and atriopore. In 1932 Boring and Li described some of the characters of the Amoy amphioxus with reference to its systematic position, and regarded it as belonging to *Branchiostoma belcheri* Gray. In the same year E. Hartmann wrote some notes on the conditions prevailing at the amphioxus fishing grounds. In 1933 T. Y. Chen and T. G. Chin made a survey of the amphioxus fisheries. In 1934 J. G. Ling wrote a short article about the fisheries. In the same year K. S. Lou made a careful chemical analysis of the Amoy amphioxus. In 1935 C. Liu and W. T. She made an analysis of the sea water of Amoy Harbour, a part of the analysis being related to the amphioxus ground. In the same year S. Y. Koo wrote a short article on the variation of the velar tentacles of the Amoy amphioxus. In 1936 T. Y. Chen compiled the data on the history of the Amoy amphioxus from the natives of southern Fukien Province. In the same year S. Tchang and K. C. Koo published the systematic position of the Amoy amphioxus, and confirmed the previous identification of *Branchiostoma belcheri* Gray. In 1939 T. G. Chin published a list of diatoms found in the intestine of adult amphioxus, and in the same year published some polychæte annelids collected from the amphioxus ground.

SOME STRUCTURES OF THE AMOY AMPHIOXUS

The morphology of the amphioxus has been extensively worked out by various authors, especially Goodsir, J. Müller, and H. Rathke. The present treatment is particularly concerned in some of the structures indicating the systematic position of the Amoy amphioxus and other interesting phenomena observed, such as the regeneration of the tail region, the branch cirrus, the hermaphroditic amphioxus, and the abnormal gonads.

Length.—The smallest individual seen with fully grown gonads is 29 mm long, and the largest, 57 mm, while the average fully-grown amphioxus is from 42 mm to 47 mm long. The detailed measurements of the length of the Amoy amphioxus will be discussed later in the study of its rate of growth. Fifty individuals were carefully measured for the three regions; namely, the preatrioporal, preanal, and postanal regions. The measurements and their ratio are shown in Table 1.

TABLE 1.—*Length of three regions in amphioxus and their ratio.*

Region.	Length.		
	Average.	Range.	Ratio.
	mm.	*mm.*	*mm.*
Preatrioporal	29.7	25.0–35.0	69.40
Preanal	9.7	8.0–12.0	22.66
Postanal	3.4	2.5– 5.0	7.94
Total	42.8	35.5–52.0	100.00

Number of myotomes.—The number of myotomes is variable in different individuals even of the same size. However, their number is characteristic for the species. The myotome formula of the present species is shown in Table 2.

TABLE 2.—*Number of myotomes in amphioxus.*

Region.	Average.				Range.			
	Present author.	Boring & Li.	Tchang & Koo.	Franz.	Present author.	Boring & Li.	Tchang & Koo.	Franz.
Preatrioporal	38	37	36	37	36–39	35–38	34–39	37–38
Preanal	17	17	28	17	16–18	16–18	--------	16–19
Postanal	10	10	--------	10	9–11	8–11	27–30	9–10
Total	65	64	65	64	63–66	62–65	62–66	63–66

The figures in Table 2 show clearly that the total number of myotomes of the Amoy amphioxus, counted by various authors, is very much the same; that is, 64 or 65. This number is within the range of myotomes for *Branchiostoma belcheri* Gray in Franz's "Systematische Revision der Akranier."

Number of gonads.—The number of gonads is not always correlated to the length of the animal, and is usually one, two or three less on the left side than on the right. The number of gonads is shown in Table 3.

TABLE 3.—*Number of gonads in amphioxus.*

Region.	Present author.		Boring & Li, range.	Tchang & Koo, range.	Franz, range.
	Average.	Range.			
Left side	25	22–28	25–28	24–27	24–28
Right side	27	23–29	----------	25–29	26–30
Total	52	45–57	50–56	49–56	50–58

Number of cirri.—The number of cirri is the same on both sides of the body, although it may vary among different individuals. It is less in young forms. The number of cirri of larger specimens counted by the present author and others is shown in Table 4, which shows that the figures are closely similar.

TABLE 4.—*Number of cirri in amphioxus.*

Region.	Present author.	Boring & Li.	Tchang & Koo.	Franz.
Average	42	----------	50	52
Range	36–50	44–50	44–56	----------

Number of fin rays.—The fin rays of amphioxus may be divided into two kinds, dorsal and ventral. The dorsal type may be subdivided into preatrioporal, preanal, and postanal. The number of fin rays varies among different individuals, as shown in Table 5. The number of fin rays given by the present author and Tchang and Koo is the same, but differs from Franz's record. This character, as the present author believes, is not very important.

TABLE 5.—*Number of fin rays in amphioxus.*

Fin ray.		Present author.		Tchang & Koo.	Franz.
Dorsal	Preatrioporal	222–298(240)	313	305–338(321)	280
	Preanal	38–82 (66)			
	Postanal	2–13 (7)			
Ventral		35–90(72)		76–94(83)	65

Number of velar tentacles.—The number of velar tentacles is variable as are many other characters. Their variations are related to the age of the amphioxus; the younger the specimen the less the number of velar tentacles, without relation to sex.(22) The number of velar tentacles is shown in Table 6.

TABLE 6.—*Number of velar tentacles in amphioxus.*

Author.	Average.	Range.
Koo	17.5	11–22
Tchang and Koo	16.0	11–20

Regeneration of amphioxus.—In spite of the fact that amphioxus is a primitive chordate, the power of regeneration is rather limited. If any part of the body of amphioxus is injured it does not regenerate, due to the presence of numerous ciliates. Numerous individuals of amphioxus were examined during the study of growth, and only one specimen was found to represent the regenerated form.

The regenerated part of the individual under consideration is the postanal region, which is smaller and shorter than in the normal individual. The difference is shown in Table 7.

TABLE 7.—*The length of the normal postanal and of the regenerated postanal regions in amphioxus.*

Region.	mm.
Normal	3.4
Regenerated	1.6

The myotome number is the same in the regenerated specimen as in a normal individual, and the thickness and the length of each myotome is therefore reduced to less than half the original size. The upper arch of the postanal region is in a straight line, while the lower arch is concave or enlarged at the middle. Between the preanal and the postanal region there is a depression, which indicates the regenerated point. Besides these, there is also a peculiarity in the fin rays. A normal specimen usually has 7 fin rays, while in the regenerated postanal region not a single fin ray can be found. Being skeletal in structure, the fin rays perhaps cannot regenerate. Text fig. 1 shows a regenerated tail.

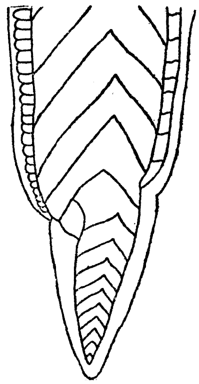

FIG. 1. The regenerated tail.

Aside from this single case of natural regeneration, experimental work leading to artificial regeneration was tried, but not a single specimen showed any sign of regeneration.

Branched cirrus.—One branched cirrus was found. The number of cirri on the same specimen was 23 on the left side and 22 on the right. One of the cirri from the right was branched into two. The branched cirrus is of normal length, but divides midway into two equal cirri, the cartilaginous skeleton within which it was found also being branched into two to conform to the external appearance. Text fig. 2 shows the branched cirrus.

The branched cirrus is either due to the union of two cirri at the base or to failure of these cirri to separate during embryological development.

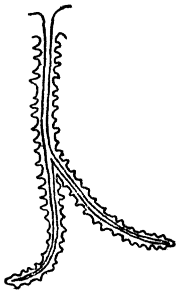

FIG. 2. The branched cirrus.

Abnormal-sized gonads.—The usual number of gonads is 52, while an abnormal male amphioxus contained only 11 testes altogether, 5 on the left side and 6 on the right. This kind of abnormality is very rare, having been found so far in only one specimen. The testes lie at the posterior half of the atrium and occupy only $\frac{3}{5}$ of the cavity.

The first and the third testes on the left side are poorly developed. They are thin and small, but the rest are unusually enlarged, into 3 to 5 times the size of the normal testis. The other 6 testes on the right side are more or less uniform in size and are nearly twice as large as the normal testis. Table 8 shows the arrangement of testes in the abnormal specimen.

TABLE 8.—*The arrangement of testes in the abnormal amphioxus.*

Side.	Number of testes. (*T*, unusually developed testis; *t*, poorly developed testis; O, no testis or gonad.)						
Left	O O O O O O O O O	t t	T T T T	t t t	T T T T	T T T	O
Right	O O O O O O O O O O O O O	T T	T T	T T	O O	T T	T T

This unusual enlargement is most likely due to reduction of the other testes. This phenomenon is also uncommon among other living organisms, and the present record is the first for amphioxus. Text fig. 3 shows the abnormal gonads.

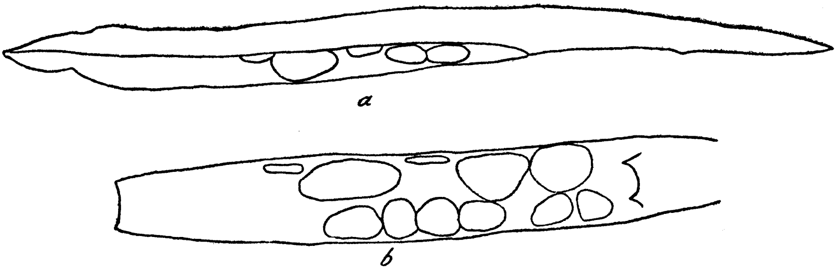

FIG. 3. The abnormal gonads. *a*, lateral view; *b*, ventral view.

Hermaphroditic amphioxus from Amoy.—The hermaphroditic amphioxus has been reported from many localities. In 1876 Langerhans detected the tails of spermatozoa among young ovaries of amphioxus. In 1912 Goodrich found a hermaphroditic specimen from Naples, containing one egg pouch on a male specimen. In 1914 Orton also described a male specimen containing one egg pouch from Plymouth. In 1922 Riddell described another case. And in 1931 T. Y. Chen, of the University of Amoy, described a specimen of the Amoy amphioxus containing equal numbers of ovaries and testes.

The hermaphroditic specimen from Amoy is an extraordinarily beautiful find, due to the arrangement of the creamy-white testes and the lemon-yellow ovaries. Table 9 shows the arrangement of testes and ovaries in the hermaphroditic amphioxus seen.

TABLE 9.—*Arrangement of testes and ovaries in an hermaphroditic amphioxus.*

Side.	T, testis; O, ovary; —, no gonad.
Left	T T T O T O O T T O - - - - T T O O T O O O O T
Right	T - T O O T T O T T O - - - - O O O O T O T T O T

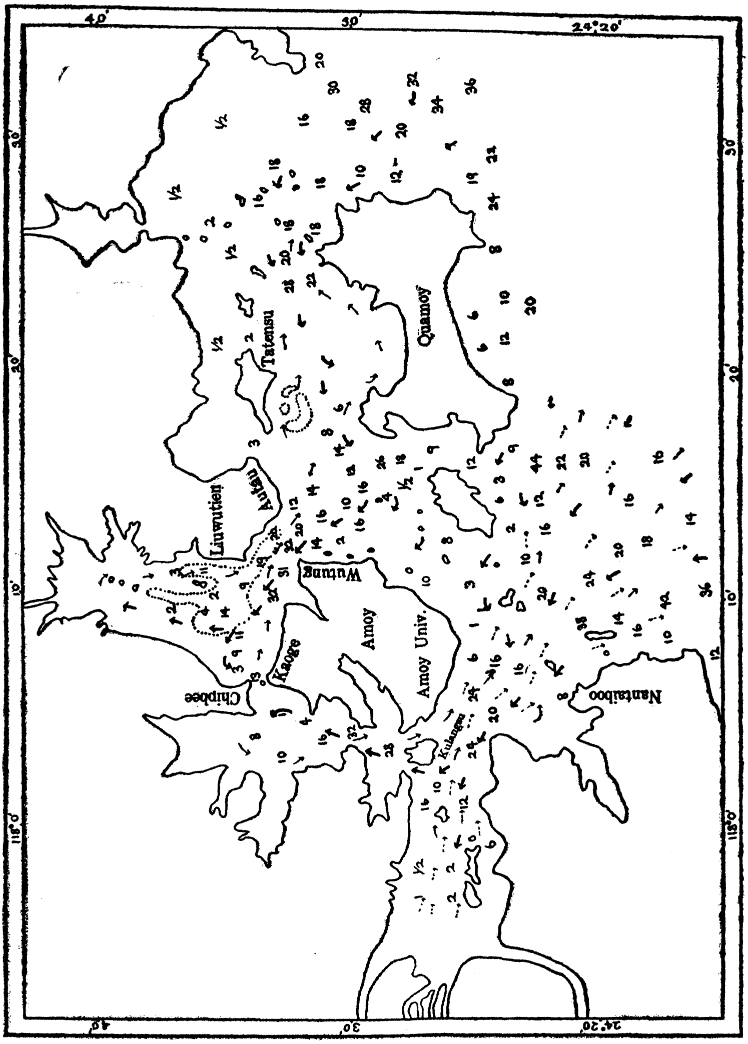

FIG. 4. Map of Amoy and its vicinity, showing the currents in ebb tide (—→), flood tide (—→), and fresh water (- - →) from inland, the depth of the sea in meters; and the Amoy and Quamoy amphioxus grounds.

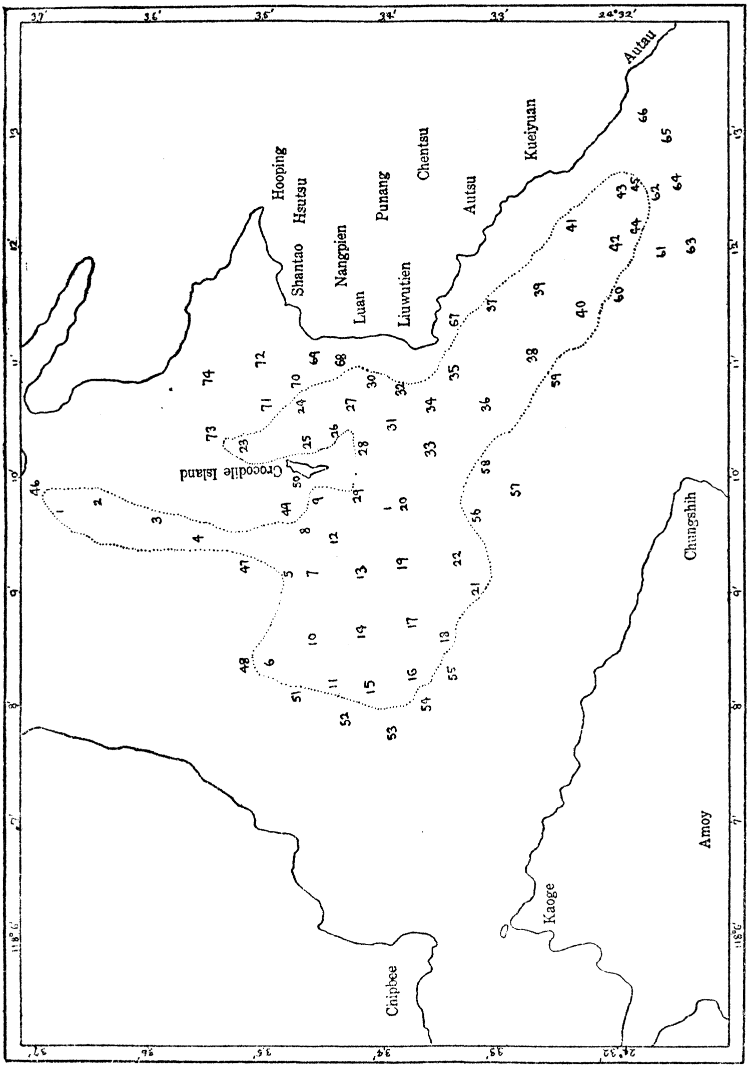

FIG. 5. Map of Amoy amphioxus grounds, showing the station numbers and the fishing villages.

ECOLOGICAL STUDY OF AMOY AMPHIOXUS GROUNDS

Amoy is located along the southeastern coast of China, between the North Temperate and Subtropical zones. The primitive chordate amphioxus has therefore found its best home there.

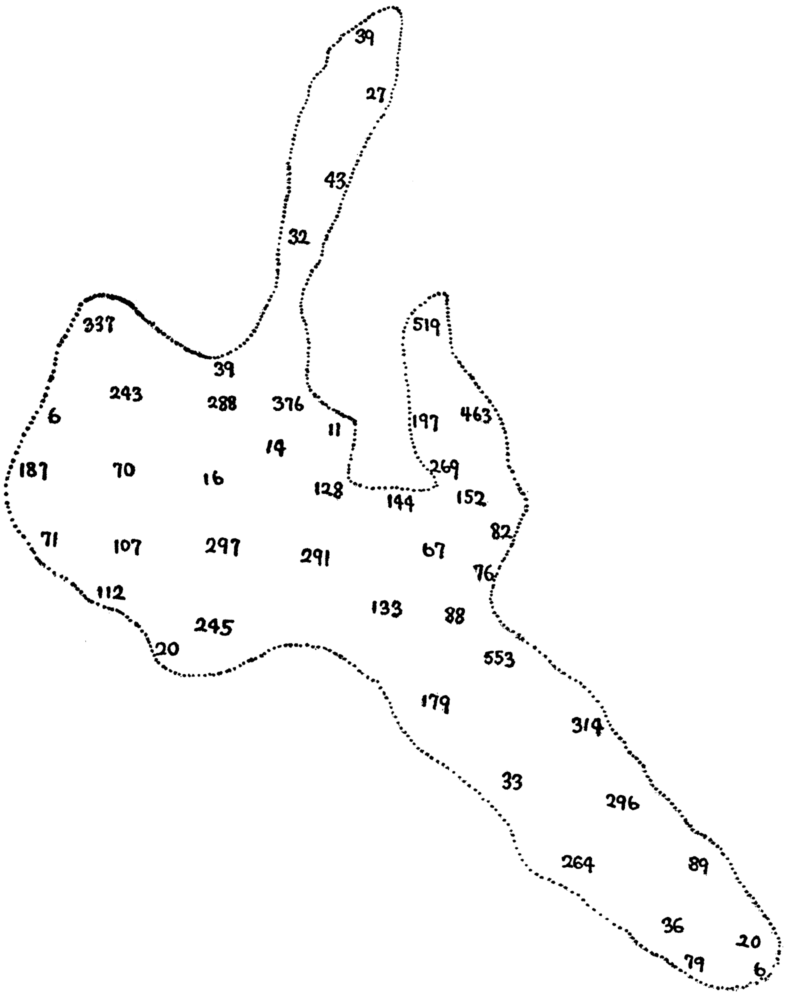

FIG. 6. Map of Amoy amphioxus grounds, showing the distribution of the number of amphioxus in a 1,000 cc sand sample in each station.

The species is abundant, 35 tons being captured yearly. Hence the study of the physical, chemical, and biological conditions of the ground is not only interesting but also of practical importance.

The exact amphioxus grounds are on the mainland, to the north of Amoy Island, very near a small town called Liuwutien. The area of the grounds is approximately 9 square miles.

The present survey was made in June, 1932, in a motor boat and a small native fishing boat. Seventy-four stations were studied. Text figs. 4, 5, and 6 show maps of Amoy and vicinity, the stations, and the distribution of amphioxus.

PHYSICAL CONDITIONS

Size of bottom particles.—The method of measuring the size of particles from the amphioxus ground is by drying in the sun a bottom sample of 1,000 cc from each station. Then the sample is allowed to pass through a set of sieves,[1] consisting of eight different grades, namely, particles that cannot be sifted through sieve 12, and particles that can be sifted through sieves 12, 18, 30, 60, 90, 100, and 120. Sieve 12 has the largest meshes, and sieve 120 the smallest. The volume of the sample is increased after classification, since particles of the same size are grouped together. Therefore the percentage is used in the final results for comparison. Tables 10 and 11 and text fig. 7 show the characteristic bottom for amphioxus.

The amphioxus lives in sandy ground, which consists of numerous large particles (sieves 12 to 30), and few small particles (sieves 90 to 120). If the condition is reversed, no amphioxus is found. This circumstance may be explained in two ways. Firstly, the mud ground is harder than sand, so the amphioxus cannot burrow in it. Secondly, the fine sand easily interferes with the respiration of the animal, as has been proved in the laboratory.

The sand and mud grounds at Liuwutien are rather distinctly separated. Two scoops of samples were taken about 5 feet apart, one of them containing sand and many amphioxus individuals, while the other contained mud and sponge. Three exceptions, stations 47, 70, and 71, probably very close to the mud ground, were dredged from the very edge of the ground containing sand but no amphioxus.

The number of amphioxus from two scoops of samples (about 1,000 cc) varies with each station, from 6 to 553 individuals. The average is 156.85 individuals and the mode 100 individuals. The number of individuals collected from each station is shown in Table 10 and in text fig. 6, as well as in Table 12.

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[1] Made by Flatters and Gurnett Company, England.

TABLE 10.—*Detailed data of bottom samples collected from the amphioxus grounds.*

Station.	Depth.	Number of amphioxus.	Sizes of bottom particles.							
			Cannot be sifted through sieve 12.	Can be sifted through sieves—						
					18	30	60	90	100	120
	m.			*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
1	4.7	39	165	240	320	450	29	2	1	1
2	4.7	27	185	220	305	260	44	4	1	2
3	2.5	43	120	140	265	530	50	3	1	2
4	3.0	32	150	215	285	470	58	6	1	2
5	2.0	39	50	100	180	510	248	80	11	16
6	2.5	337	30	73	175	700	120	11	3	4
7	3.5	288	175	290	350	370	12	1	1	1
8	7.5	376	80	150	320	520	50	8	2	2
9	4.7	11	40	160	400	460	34	2	1	1
10	7.5	243	110	160	320	520	56	4	1	2
11	4.7	16	210	225	295	410	44	2	1	1
12	10.5	14	1	5	77	950	100	7	1	2
13	9.5	6	1	11	58	950	45	4	2	1
14	6.5	70	45	140	410	520	12	1	1	1
15	4.7	187	200	220	295	420	35	6	1	3
16	6.5	71	100	250	460	310	10	1	1	1
17	6.5	107	75	205	425	405	16	3	1	1
18	4.7	112	175	190	390	370	22	4	2	3
19	9.5	297	60	155	335	530	40	2	2	2
20	7.5	291	60	190	450	400	15	1	1	1
21	7.5	20	15	110	510	460	12	2	1	1
22	6.5	245	260	200	340	275	2	2	4	2
23	9.5	519	400	240	225	275	45	4	2	2
24	13.0	463	125	160	320	475	85	10	3	7
25	9.5	197	65	180	410	410	56	3	1	1
26	7.0	269	60	95	225	670	48	2	1	3
27	8.5	152	200	300	300	255	10	2	1	1
28	6.5	144	35	185	435	420	10	1	1	2
29	5.5	128	130	210	460	310	9	2	1	2
30	9.5	82	220	280	250	395	50	7	3	3
31	8.5	76	75	255	555	195	10	1	1	1
32	14.5	67	45	120	410	480	33	7	2	3
33	7.5	133	175	270	410	240	15	1	1	1
34	11.0	88	105	300	440	270	9	2	1	1
35	9.0	553	55	115	370	550	25	2	1	2
36	8.8	179	30	130	360	545	21	1	1	2
37	9.5	314	5	45	175	735	90	7	2	3
38	10.0	33	15	77	210	725	61	1	1	1
39	9.5	296	5	30	125	800	120	8	2	3
40	10.0	264	110	230	405	330	14	1	1	2
41	9.5	89	30	87	260	550	180	11	1	2
42	11.5	36	20	65	360	560	73	6	1	2
43	14.5	20	55	125	340	550	32	10	2	3
44	13.5	79	300	245	225	405	32	2	2	4
45	16.0	6	60	140	165	110	4	1	1	1
Total	359.3	7,058	4,627	7,533	14,310	20,945	2,078	248	73	108
Average	7.98	156.85	102.82	167	318	465.40	46.20	5.51	1.62	2.40
Percentage	-------	--------	9.29	15.11	28.73	42.05	4.17	0.41	0.15	0.28

TABLE 11.—*Detailed data of bottom samples collected from the vicinity of amphioxus grounds.*[a]

Station.	Depth.	Sizes of bottom particles.							
		Cannot be sifted through sieve 12.	Can be sifted through sieve—						
			12	18	30	60	90	100	120
	m.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
46	4.7	250	210	98	300	58	5	4	430
47	2.0	25	40	120	835	77	3	1	2
48	3.0	20	55	125	290	105	18	18	170
49	10.5	140	125	230	90	24	2	2	565
50	8.5	410	165	135	220	195	25	10	20
51	7.5	100	12	63	382	91	8	7	550
52	4.7	300	147	192	177	23	8	8	450
53	12.5	hard ground, no sample							
54	8.0	250	168	158	214	43	6	4	340
55	7.5	260	155	320	105	45	10	3	250
56	10.00	260	155	242	145	80	10	5	355
57	16.5	hard ground, no sample							
58	11.0	100	93	184	185	80	6	6	475
59	12.0	10	69	61	495	80	10	1	400
60	12.3	95	75	48	420	43	6	8	370
61	14.3	80	50	39	452	50	3	2	350
62	13.3	150	262	75	125	28	1	1	400
63	deep	no sample							
64	do.	do.							
65	13.0	70	70	58	76	31	9	8	950
66	12.0	160	150	250	151	50	6	5	600
67	9.5	150	127	105	217	70	10	10	550
68	3.5	100	265	127	120	63	12	9	550
69	3.0	200	267	210	133	12	6	4	430
70	3.0	325	340	260	240	17	1	1	1
71	3.5	10	100	450	500	15	2	1	1
72	3.5	180	175	165	183	55	3	5	500
73	2.0	100	210	182	127	23	7	6	550
74	3.5	150	160	120	360	70	20	15	350
Total	198.2	4,125	3,490	4,027	6,042	1,428	197	143	9,809
Average	7.93	165	140	161	242	57	8	6	392
Percentage	--------	14.1	11.9	13.8	20.7	4.9	0.7	0.5	33.5

[a] No amphioxus were found in these samples.

This variation may be explained in three ways: (*a*) the samples dredged by the native scoop are not even, since the construction of the dredging scoop is too simple and the movement of the water varied, especially during the winding time; (*b*) the distribution of the amphioxus themselves is not even, since they can migrate slightly in the ground; (*c*) it depends upon the number of fishing boats at the station—the more the fishing boats the less will be the number of amphioxus individuals per boat.

In June the proportion between the first-year, and the second-year and third-year amphioxus is about 7:10 on the average,

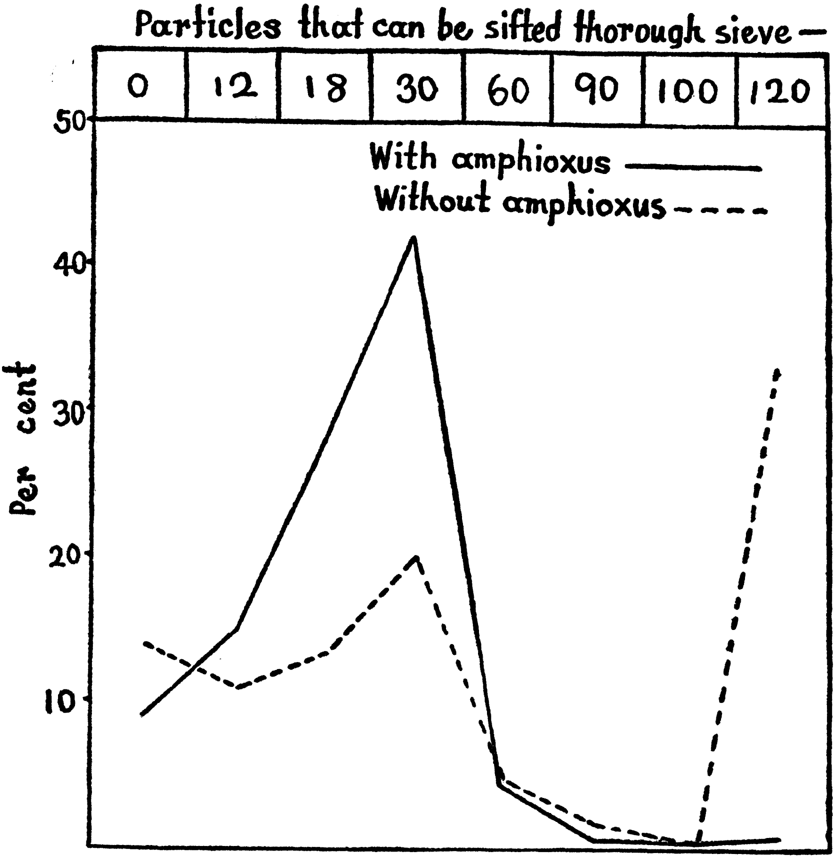


FIG 7. Differences between bottom samples with and without amphioxus, collected from amphioxus grounds and their vicinity. O represents the largest particles of sand that cannot be sifted through sieve 12. 12, 18, 30, 60, 90, 100, and 120 represent particles that can be sifted through the corresponding sieve. 120 is the finest sieve.

TABLE 12.—*Variation in the number of individuals of amphioxus collected from each station.*

Individuals.	Frequency.
1–10	2
11–50	5, 5, 2
51–100	5, 3
101–150	5
151–200	4
201–250	2
251–300	5, 1
301–350	2
351–400	1
401–450	0
451–500	1
501–550	1
551–600	1

but at stations 6, 23, 24, 35, 37, and 39 the individuals are mostly small, since the fishermen usually capture large amphioxus and leave the small individuals.

Depth of the sea.—The amphioxus fishing ground is rather shallow. Sixteen meters was the greatest depth found in this survey, and the amphioxus is also present in the littoral region. The pressure is rather high at a depth of more than 16 meters, but the ordinary air pressure does no harm to the organism. The average sea bottom for amphioxus ground is about 8 meters. The depth of Amoy Sea and its vicinity is shown in text fig. 4, and the detailed data of the ground is given in Table 10. Text fig. 8 shows a section of the sea from Chipbee, and text fig. 9 shows sections of the sea in the amphioxus ground.

Figure 8 is a section of the sea from Chipbee to Liuwutien through Crocodile Island. It shows the presence of amphioxus at different depths and its habitat in general.

Water current in the amphioxus ground.—The amphioxus, especially the younger stage, is not present where a strong current exists. However, a certain amount of current is necessary, since transports food material from the open sea to the feeding grounds. The speed of the water current depends upon the depth of the sea; that is, water currents are stronger in deeper waters. The entrance of the sea water at the North of Amoy Island, from Wu Tung to Au Tau, is shown in text fig. 9, *a*. No amphioxus was found in waters where the bottoms are muddy; as from Wu Tung to Liuwutien and Chung Shih to Liuwutien, shown in text fig. 9, *b* and *c*, which shows a deep groove on the bottom near Amoy Island. The ground with sandy bottom was found to be inhabited by amphioxus. Near the mainland, where the water current was quite slow, the sandy bottom was rather shallow.

The sea between Chung Shih, Chipbee, and Liuwutien is much wider, therefore the current decreases and makes it rather shallow, as shown in text fig. 11.

Text fig. 9, *d*, is a section between Kao Ge and Chipbee. This section, which is quite narrow and shallow, separates the north and south sea waters of Amoy. It is said that several hundred years ago people could walk through this portion during low tide. This narrow neck is quite beneficial to the amphioxus, otherwise fresh water in the southern part of Amoy Sea would get in, dilute the water in the amphioxus ground, and kill the animals.

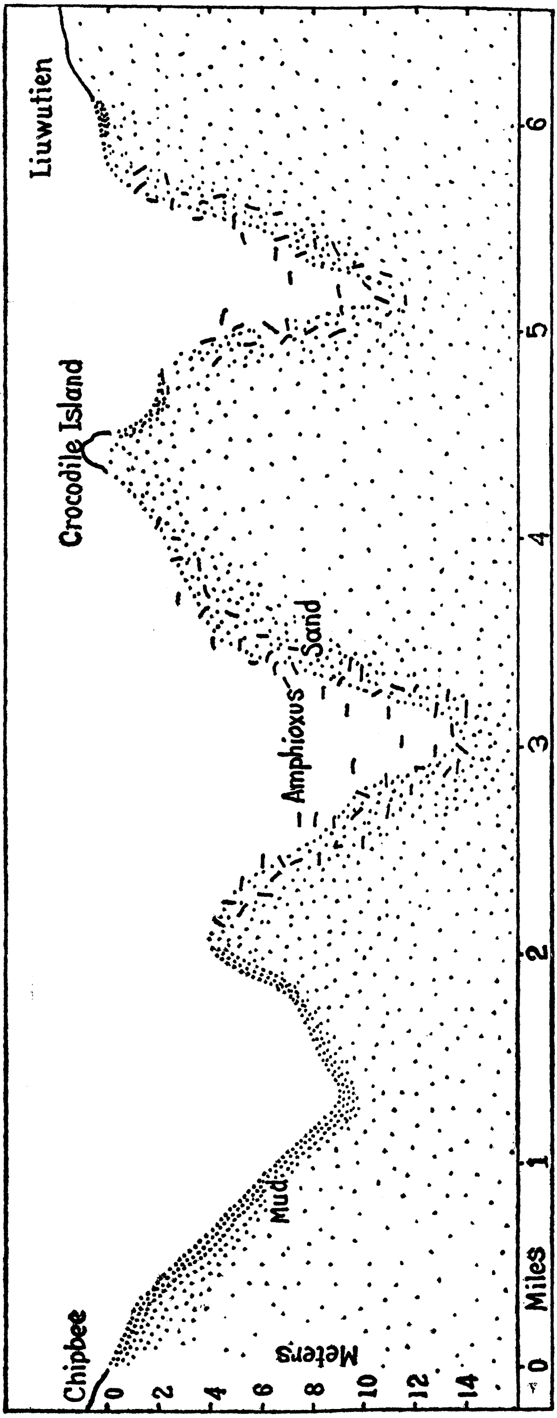


FIG. 8. Section of the sea from Chipbee through Crocodile Island to Liuw utien, showing the nature of the bottom and the distribution of amphioxus.

Specific gravity of the ground sample.—The specific gravity of the sand from the amphioxus ground is comparatively low, since the amphioxus is a sand-burrowing animal. It is not as low as that from the outer shore, where numerous broken calcareous shells are present. In the amphioxus ground there are many broken molluscan shells and other calcareous substances, such as the coral skeleton, echinoderm plates, appendages of crabs, and bones of higher vertebrates. These substances constitute more than 4 per cent of the sample.

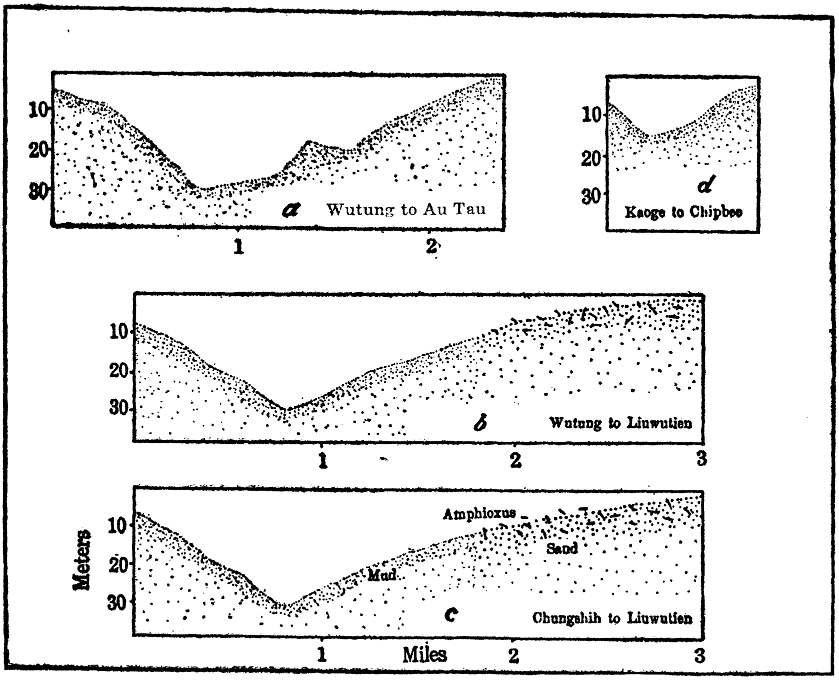


FIG. 9. Sections of the sea in the amphioxus grounds and their vicinity, showing depth and bottom conditions from which the directions of water currents are plotted.

In order to make a comparison on the specific gravity, sand samples were collected from different localities in Amoy and its vicinity, namely: Light House, Chipbee, Nantaiboo, and in front of the University of Amoy. Among them the sand from Light House was the lightest, containing the largest amount of calcareous substances (calculated by carbon dioxide producing power of the sample by adding acid solution), since it was on the margin of the open sea. The Liuwutien sample (amphioxus ground) was next, while the remaining samples contained smaller particles of sand and less calcareous substances, and

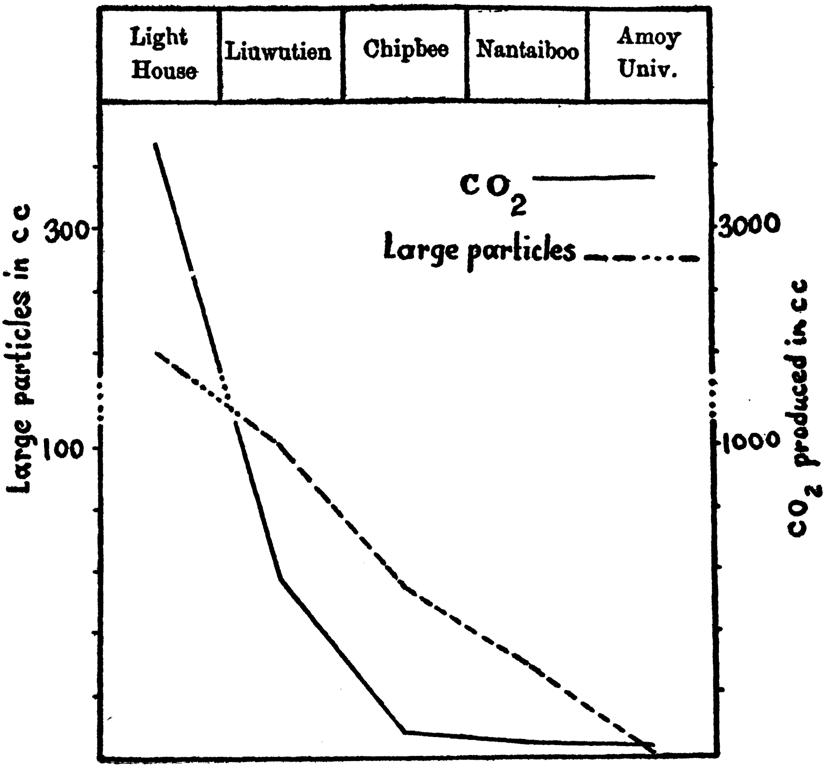


FIG. 10. Correlation between the large particles and carbon dioxide produced.

hence were higher in specific gravity. Table 13 shows a comparative study of sand samples from the amphioxus ground and vicinity. Text fig. 10 shows the correlation between the large particles and the carbon dioxide produced.

TABLE 13.—*A comparative study of sand samples collected from the amphioxus ground and its vicinity.*

Locality.	Volume of different sizes of bottom samples.									Density.	CO_2 produced in 100 cc of sample.
	Cannot be sifted through sieve 12.	Can be sifted through sieve—								
		12	18	30	60	90	100	120		
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
Light house....	260	425	350	135	5	2	1	1	1.3330	3250
Liuwutien.....	102	167	318	465	46	6	2	3	1.3450	592
Chipbee.......	58	170	570	350	5	2	2	1	1.4040	68
Nantaiboo	28	130	290	656	85	5	2	2	1.3845	20
Front of Amoy University....	0	2	10	980	125	9	3	8	1.3955	3

Temperature.—As has been mentioned in the early part of this paper, Amoy is located between the North Temperate and the Subtropical zones. The temperature range in the region is, therefore, not very great. In 1932 the air and water temperatures were taken weekly on the amphioxus ground. The average monthly air temperature reached the lowest level in February, and gradually increased in March and April. From April to May the temperature increased considerably, and reached its highest level in July. Then it dropped down in a smooth curve till the end of the year.

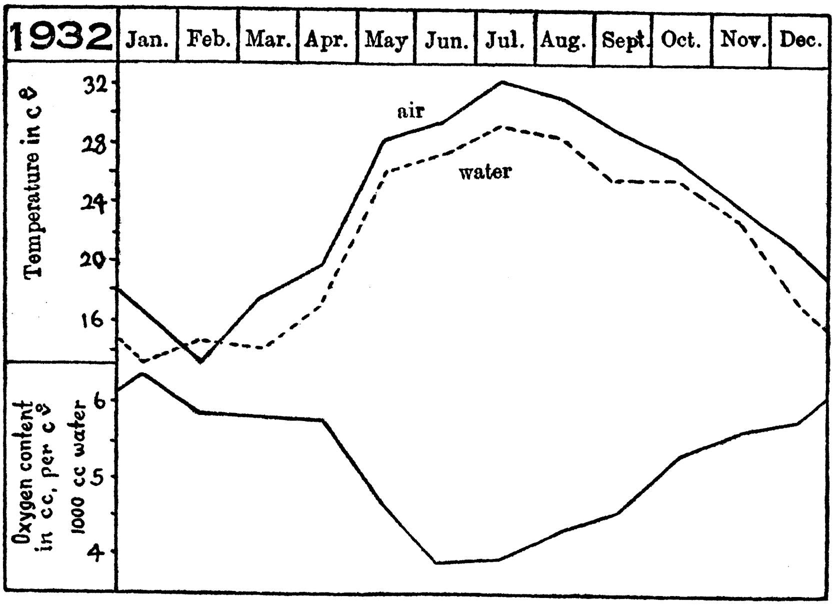


FIG. 11. Temperature and dissolved oxygen content at Liuwutien in 1932.

The lowest temperature recorded during the year was 10.5°C., and the highest, 34°C., for air temperature, and 12.0°C. and 30.5°C., respectively, for water temperature. The average air temperature was 23.5°C. while that for water was only 17.5°C.

The water temperature was always 2 to 3°C. lower than that of the air, except in February when the water temperature was higher. The air and water temperatures recorded showed clearly that the change of temperature in such shallow water was mainly due to air temperature, and was not much influenced either by warm or cold current. Table 14 and text fig. 11 show the temperature range and oxygen content at Liuwutien in 1932.

TABLE 14.—*Temperature and dissolved oxygen at Liuwutien in 1932.*

Data.	January.	February.	March.	April.	May.	June.	July.
Air temperature °C.	16.9	13.3	17.8	19.7	28.3	29.6	32.1
Water temperature °C.	13.7	14.8	14.5	17.3	26.1	27.6	29.2
Oxygen content cc per liter	6.29	5.95	5.93	5.88	4.76	3.92	3.99

Data.	August.	September.	October.	November.	December.	Average.
Air temperature °C.	31.3	29.0	27.0	24.4	21.0	24.2
Water temperature °C.	29.9	25.9	23.2	17.6	17.6	22.1
Oxygen content cc per liter	4.26	4.59	5.25	5.60	5.82	5.19

Water color, transparency, density, and other data.—The sea water is invariably deep blue and very rarely yellowish. The transparency is from about 0.5 to 2 meters for a white disc with a diameter of 20 centimeters. Since the water is clear, many planktons used as food by amphioxus are present. The density of the sea water is rather higher than in other parts of Amoy Sea, since very little fresh water enters the sea in this region. The density of sea water in relation to its salinity will be discussed later.

The rainfall reaches only the surface water and therefore does not materially influence the living conditions of the amphioxus. The inland rainfall is considerable south of Amoy, but not in the amphioxus ground. The wind at Liuwutien is rather strong, especially during the flood tide in the afternoon. But it does not influence the amphioxus directly, since it only affects the movement of the water.

CHEMICAL CONDITIONS

Salinity.—Different species of animals usually live in different degrees of salinity. If there is only slight change of salinity, the animal will adjust itself, but conspicuous changes may cause its death. If considerable amounts of fresh water enter into the sea from the inland the diluted water may swell the body of amphioxus by osmotic pressure. Amphioxus killed by osmosis assume the shape of a half moon, due to the fact that changes by osmotic pressure take place more rapidly in the gonadal region than in the muscular back. This fact was verified by tests conducted in the laboratory.

The change of salinity depends upon many factors, such as temperature, current, nature of the bottom, fresh water, and others. But the change in this region is influenced mainly by the fresh water from inland, especially during the rainy season. The higher the volume of rainfall, the lower the salinity will be. Table 15 and text fig. 12 show the salinity, rainfall, and pH value at Liuwutien and Kulangsu in 1932.

TABLE 15.—*Salinity, rainfall, and pH value at Liuwutien and Kulangsu in 1932.*

Data.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.
Liuwutien, salinity per 1,000 cc.	27.2	28.2	27.4	26.7	26.1	24.3	28.5	27.7	25.7	27.8	28.3	27.7	27.1
Kulangsu, salinity per 1,000 cc.	26.2	25.7	22.1	22.8	25.6	13.4	27.1	26.8	20.0	26.2	24.3	25.5	23.8
Amoy Island, rainfall mm.	0	31	113	192	145	226	155	174	123	0	18	45	101.9
Liuwutien, pH value	8.40	8.40	8.36	8.40	8.36	8.40	8.40	8.40	8.36	8.40	8.35	8.40	8.39
Kulangsu, pH value	8.40	8.33	8.32	8.30	8.35	8.36	8.40	8.32	8.30	8.40	8.30	8.40	8.35

A sample of 10 cc sea water was taken and titrated with the usual solution of silver nitrate used in this determination, and then calculated into salinity per 1,000 cc of water. The average salinity at Liuwutien was 29.1 grams per liter, highest in July (30.5 grams per liter), and lowest in June (26.3 grams per liter). The highest for each collection was 31.8 grams per liter, at the end of July, and the lowest, 24.4 grams per liter, at the beginning of June. The range was only 7.4 grams per liter.

This condition is quite different on the south side of Amoy Sea, which is the outlet of a large river. At the beginning of June the sea was nearly filled with fresh water, containing only 5.2 grams per liter salts. At the end of July the salinity reached 31.7 grams per liter. The difference is 26.5 grams per liter. Such great changes killed many sea animals during the rainy season. It is quite fortunate that the sea water of the south and the north is not easily mixed, on account of the different current systems, the presence of the shallow and narrow strait between Kao Ge and Chipbee, and the production of the main fresh current near the south end of South Amoy Sea where a deep groove is present.

Hydrogen-ion concentration.—The hydrogen-ion concentration of sea water affects the respiration and other physiological conditions of the animal. It is, therefore, important in the ecological study of amphioxus.

For the pH value, colorometric determination by a comparator block was used. To 10 cc sea water is added 0.5 cc 0.2 per cent cresol red, and the sea water is then compared with the standard color disc against light. Sixty-four samples were tested, all except 5 having a value of 8.4. The exceptional 5 were a little higher (8.6) and lower (8.2). In the southern part (Table 15 and text fig. 12) the pH value was usually very low, due to the fresh water from inland and organic matter from Amoy City.

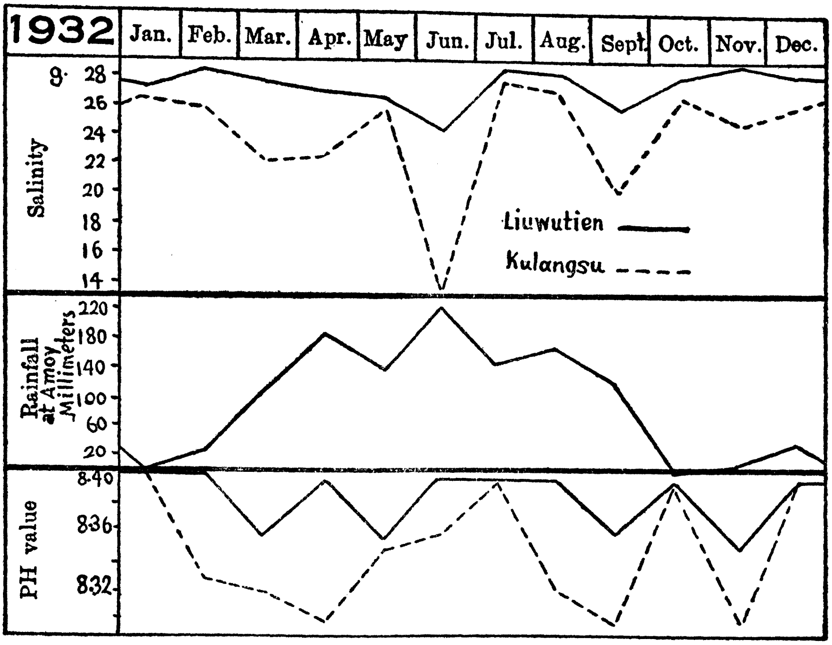


FIG. 12. Salinity and pH value at Liuwutien and Kulangsu; and rainful at Amoy in 1932.

The pH value of the bottom samples was also tested. One cc sand or mud was added to 12 cc of water, and the water shaken thoroughly and allowed to stand till clear. Ten cc of the superficial water were then poured into the test tube and tested as above. The sand sample had a pH value of 8.4, like the sea water itself, while the mud sample gave a much higher acid value, 7.2. This factor probably helps to explain why amphioxus cannot live in muddy ground.

Dissolved oxygen.—The dissolved-oxygen content is essential for the respiration of the animals. Its fluctuation depends mainly upon the temperature of the water. At low temperature the water contains more oxygen, and at high temperature it contains less oxygen. Winkler's method was used in the oxygen determinations. The lowest record was 3.92 cc per 1,000 cc water in June and 6.29 cc per 1,000 cc in January, the latter being the highest in average. The yearly average was 5.19 cc in 1932.

Other chemical conditions.—The detailed analysis of the sea water from the amphioxus ground was worked out by Liu and Shé.(27) The data of these workers were based upon three collections in the fall and winter of 1932, and spring of 1933.

Most of the elements or compounds mentioned in this paper are not directly related to amphioxus, but they are related to the chemical composition of the sea water and growth of food materials. For this reason the results of the analysis are given in Table 16.

TABLE 16.—*Chemical analysis of sea water from amphioxus grounds.*

Substance.	Fall.	Winter.	Spring.
	p. p. m.	*p. p. m.*	*p. p. m.*
Nitrate	0.2440	0.8060	0.5230
Nitrite	0.1310	0.4270	0.2300
Phosphorus pentoxide	0.0020	0.0040	0.0034
Sulfate	2290.0000	2230.0000	2150.0000
Carbonate	8.4000	9.0000	8.9000
Bicarbonate	98.2000	97.6000	99.4000
Chloride	14705.000	16,906.0000	16,706.0000
Bromide	55.8000	56.0000	56.8000
Iodine	----------	----------	0.0190
Saline ammonia	7.0400	8.2600	7.5300
Albuminoid ammonia	38.3000	40.8000	41.4000
Silica	2.0000	2.5000	1.5000
Potassium	365.0000	359.0000	328.0000
Sodium	10,140.0000	9,940.0000	10,620.0000
Calcium	323.0000	342.0000	320.0000
Magnesium	1,152.0000	1,166.0000	1,126.0000
Iron	0.2000	0.0200	0.0400

Among the above elements or compounds, nitrate, nitrite, phosphorus pentoxide, and silica affect the growth of diatoms. Carbonate and bicarbonate affect pH value. Cloride, bromide, iodine, potassium, sodium, calcium, magnesium, and iron affect salinity. Saline ammonia and albuminoid ammonia affect bacteria in the water.

BIOLOGICAL CONDITIONS

Animals and plants used as food by amphioxus.—Microscopic plankton in the sea water, small protozoa, small plants, and decomposed material at the bottom constitute the chief food of amphioxus. The commonest among them are the diatoms.

More than 200 young (less than 8 mm long) amphioxus were examined, and only small diatoms were found in their digestive tracts. The commonest species were *Paralia sculata, Coscinodiscus lineatus, Nitzchia* spp., *Navicula* spp., and *Rhizosolenia* spp. More than 200 large (45 to 50 mm long) amphioxus were examined by squeezing the fæcal matter out from the intestines and treating the latter with acid. The diatoms observed were *Podosira stelliger, Actinocyclus Ehrenbergi, Coscinodiscus lineatus, C. excentricus, C. subtilis, C. marginatus, C. asteromphalus, Cyclotella striata, C. stylorum, C. comta, Actinoptychus undulatus, A. annulata, Triceratium favus, T. Broeckii, Biddulphia pulchella, Trachyneis aspera, T. clepsydra, Navicula crabro, N. elliptica, N. lyra, N. longa, N. directa, N. abrupta, Amphora commutata, Pleurosigma Normanii, P. pelagicum, P. naviculaceum, Surirella fluminensis, Campylodiscus* (?) *cocconeiformis,* and *Nitzschia punctata.*(8)

The following planktonic organisms were commonly collected from the sea water of the amphioxus ground. All of them were easily dissolved by hot acid. Some of them were dissected from the pharynx or intestines of living amphioxus. The forms collected were *Corethron criophillium, Chaetoceras decipiens, Biddulphia sinensis, Asterionella formosa, Leptocylindrus denicus, Coscinodiscus lineatus, Thallassiothrix nitzschioides, Guinardia* sp., *Eucampia zodiacus, Rhizosolenia shrubsolei, Noctiluca scintillans,* tunicate larvæ, echinoderm larvæ, crustacean larvæ, and copepod larvæ.

Animals that seem to be indifferent to amphioxus.—Three groups of animals were found in the amphioxus grounds, namely: molluscan shells, annelids, and crabs. Some of them are beneficial and others harmful, but most of them are apparently indifferent to amphioxus.

Molluscan shells:

Murex martinianus Reeve, few; *Ranella tuberculata* Bred., few; *Surcula tuberculata* Gray, rare; *Engrina sinensis* Melville, rare; *Natica fortunei* Reeve, rare; *N. maculosa* Lamarck, few; *Pyramidella elegans* (Adams), few; *Scalaria obesa* Sowerby, rare; *S. acuminata* Sowerby, rare; *Potamides fluviatilis* (Potiz and Michaud), few; *Triforis fusca* Dunker, rare; *Euchelus horridus* (Philippi), common; *Retusa cecillei* (Philippi), common; *Cuma grada* (Jonas), abundant; *Eburna lutosa* Lamarck, few; *Erillia lanceolata* (Reeve), rare; *Turritella bacillum* Kien, common; *Turbonilla terebra* Dunker, few; *Scalaria aculeata* Sowerby, few; *Cerithium rubus* (Martin), few; *Minolia stigata* Sowerby, common; *Columbella dunkeri* Tryon, few.

All the above specimens were dredged at Liuwutien during the study of the distribution of amphioxus. With the presence of these shells and other calcareous materials the amphioxus ground is always kept at a pH value 8.4, which is the optimum condition for the amphioxus.

Annelids:

Table 17 shows the annelids found in the amphioxus ground.

TABLE 17.—*Annelids found in the amphioxus ground.*

Name.	Specimens collected.	Time of collection.
Clymens (*Euclymens*) *insecta* Ehlers	few	June.
Diopatra dentata Kinberg	do.	Mar.–June.
Eunice gracilis Crossland	rare	June.
Glycera chirori Izuka	few	Jan.–April.
Glycera onomichinensis Izuka	abundant	Whole year.
Blycinde sp. (juvenile)	do.	Do.
Lunbricinereis ocellata Grube	do.	Do.
Lysidice collaris Grube	few	Winter spring.
Marphysa sanguinea Montagu	do.	June–July.
Nephthya sinensis Fauvel	abundant	Whole year.
Nereis sp. (juvenile)	rare	June.
Onuphis eremita Aud. & Edw.	do.	June–July.
Phyllodoce malmgreni Gravier var.	do.	June.
Polydora ciliata Johnston	abundant	Whole year.

All annelids mentioned in Table 17 (8) are indifferent to amphioxus, and they are less numerous than amphioxus.

Crabs collected by previous workers in the University of Amoy, and identified by Dr. M. J. Rathbun(39) of the United States National Museum:

Camptandrium elongatum Rathbun, *Eucrate crenata* de Man, *Ilyoplax delsmaniyuhana* Rathbun, *I. cerarophora* (Loelbel), *I. orientalis* (de Man), *Charybdis mergniensis* (de Man), *Metaplax elegans* de Man, *Sor fukiensis* Rathbun, *Uca forcipata* (Adams & White), *Parapanope euagora* de Man, *Sesarma* (*Parasesarma*) *batavianum* de Man.

Enemies of amphioxus.—Starfishes feed upon amphioxus, but they are relatively scarce at Liuwutien. Fishes also feed upon amphioxus, especially the larvæ. Many kinds of infusoria, such as *Oxytrica ferruginea* Stein, *Euplotes harpa* Stein, and others, in the amphioxus grounds, are also harmful to amphioxus. Ciliates easily kill amphioxus by infecting them through injured parts, however small the wounds may be.

The tide is also harmful to amphioxus during the breeding season, since it carries away young amphioxus to unsuitable places.

As a whole, the so-called unfavorable conditions found in Amoy waters are not sufficient to cause the depletion of amphioxus.

Fisheries.—Man catches amphioxus for food. However, since the amphioxus on the ground are quite numerous, and people usually do not fish amphioxus during the breeding season, the amphioxus fishery is well protected from depletion.

HOW TO KEEP AMPHIOXUS ALIVE IN THE LABORATORY

The above studies clearly determined the optimum environment of amphioxus, and with the information obtained I was able to keep amphioxus alive in the laboratory. They were kept in good health in the laboratory for 8 months, and died only after I left Amoy. Square (6- by 6- by 10-inch) museum jars were used for holding five to ten individuals. Essentially each jar contained clear sea water and a sandy bottom about 0.5 inch thick. Favorable conditions essential to the life of amphioxus include the following:

Health.—The regenerating power of the amphioxus is very low. An injury of the skin does not heal readily, so that the wounded portion is infected by many kinds of infusoria and bacteria, which multiply rapidly and finally kill the amphioxus. Therefore care must be observed in washing the amphioxus. If some wounded amphioxus are found they must be removed immediately. Examination for wounded individuals must be made every 12 hours during the first few days.

Hydrogen-ion concentration (pH value).—A certain range of pH value is necessary for the life of amphioxus, which can be maintained in good condition in waters between pH 7.4 and 8.6. If acidity increases to 7.2 or more the amphioxus die within a few minutes, and if alkalinity increases to 8.8 or more they also die quickly, since the water has lost its buffer reaction.

Temperature.—From the above studies we know that the optimum range of temperature for amphioxus is from 12 to 30.5° C. Within this range it is not difficult to keep them alive. But the two extreme temperatures are not suitable. The most favorable period to keep the amphioxus in the laboratory is in the spring and fall, but it is possible to keep them alive in the cold winter and in the hot summer by increasing or decreasing the temperature by artificial means, as the case may be.

Water.—Large quantities of water are necessary to keep all the physical, chemical, and biological conditions as constant as possible. All museum jars must be covered partly to cut down the evaporation of the water and to protect it from the dust in the air.

Salinity.—The most important factor relative to amphioxus in the laboratory is the amount of salinity. The changes of salinity at Liuwutien are relatively small, only 7.4 grams per liter difference during 1932. An experiment was carried out in the laboratory to test the amount of salinity required by amphioxus. The pH value of the water used was 8.4. The results are shown in Table 18.

TABLE 18.—*Amphioxus in relation to salinity.*

Salt content in 1,000 cc water.	Length of life.	Salt content in 1,000 cc water.	Length of life.
		cc.	
0.2	2 seconds	24.2	Nil.
3.0	do	29.2	Do.
5.0	1 minute	32.6	3 days.
7.5	2.5 minutes	35.5	1.5 days.
9.5	3.0 minutes	38.5	1.0 day.
11.6	3.5 minutes	41.5	3 minutes.
14.0	4.0 minutes	50.0	2 minutes.
16.2	5 days	65.0	10 seconds.
19.2	Nil	80.0	2 seconds.

Table 18 shows that between 19.2 and 29 grams of salt per liter, amphioxus can live normally. Salinity contents beyond either extreme kills the animals. The experiment has been repeated 6 times with similar results.

Food.—Amphioxus may be kept in the laboratory without food for from 1 to 2 months, but they do not grow and usually lose weight. If some microplankton is added to the water from time to time, they grow normally. Among planktons diatoms are the best food.

Summary.—In order to keep amphioxus alive in the laboratory the animals must not be injured; the pH of the water should be about 8.4; the temperature must be between 12 and 30°C.; and the salinity must be from 19 to 29 grams per liter. Moreover, the quantity of water must be kept more or less constant, and the food should consist of microplankton, among which diatoms are best. Given these conditions, amphioxus can be kept in the laboratory without much trouble.

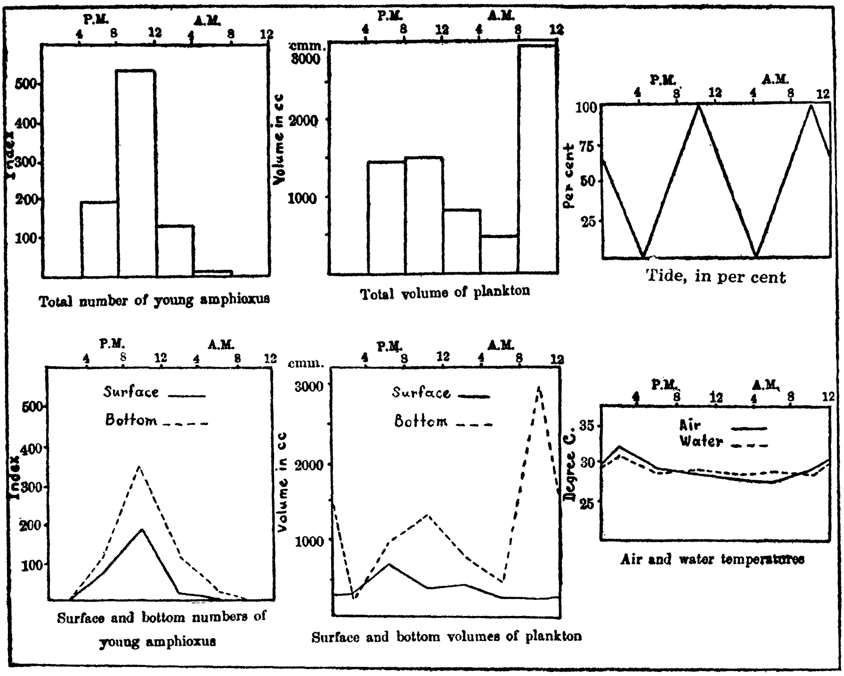
VERTICAL DISTRIBUTION OF YOUNG AMPHIOXUS

Young amphioxus are found in the plankton population by some zoologists, such as Bles(2) at Plymouth. In the summer of 1933, while I was engaged in the collection of embryological stages of amphioxus, I had opportunity to study the vertical distribution of young amphioxus. Adult amphioxus usually burrow in the sand and rarely swim in the water, but larvæ from 2 to 3 millimeters long invariably swim about and form part of the planktonic fauna of the sea.

METHODS

The plankton net used was made of raw silk, with 913 meshes per square centimeter, with a tin funnel at its tip. Two nets were used in towing, one placed near the surface and the other at the bottom of the water. The area of each net was 1,661.91 square centimeters. The net was attached to a small boat with a constant speed, traveling 1,600 meters in half an hour in all collections, so that the total volume of sea water filtered in each collection was nearly 266 liters. Concentrated formalin (with borax) was added to the water to make a 5 per cent solution. In this way the specimens are both fixed and preserved.

The oxygen content was determined according to Winkle's method, the pH value was compared with a colored disc against light by adding cresol red indicator, and the total salt concentration was calculated by the volume of silver nitrate solution used in the presence of potassium chromate indicator. The height of the tide was calculated from the tide table at Amoy and not from actual measurements. Table 19 and text fig. 13 show the physical conditions of the amphioxus ground at Liuwutien, Amoy, and the distribution of amphioxus, July 8 and 9.



Total number of young amphioxus

Total volume of plankton

Tide, in per cent

Surface and bottom numbers of young amphioxus

Surface and bottom volumes of plankton

Air and water temperatures

FIG. 13. Vertical distribution of young amphioxus and other related phenomena.

TABLE 19.—*Distribution of young planktonic amphioxus and its relation to other phenomena.*

Weather: sunny, blue sky, no wind, no clouds; locality: Liuwutien, Amoy, 24° 35′ north latitude, 118° 11′ east longitude; date: July 8 and 9, 1933; oxygen content: 3.9 cc in 1,000 cc water; pH value: 8.4; salinity: 27.2 grams in 1,000 cc water.

Date.	Time.	Tide mark.	Light intensity.	Temperature.	
				Air.	Water.
		Per cent.	*Per cent.*	°*C.*	°*C.*
July 8	2 P. M.	33.4	100	32.2	31.0
	6 P. M.	33.4	50	29.0	28.8
	10 P. M.	100.0	0	28.0	28.8
July 9	2 A. M.	33.4	0	27.7	28.9
	6 A. M.	33.4	50	27.2	29.0
	10 A. M.	100.0	100	29.0	28.9

Date.		Plankton volume.			Young amphioxus.		
		Surface.	Bottom.	Total.	Surface.	Bottom.	Total.
		cc.	*cc.*	*cc.*			
July 8	2 P. M.	228	212	440	0	0	0
	6 P. M.	707	990	1,697	73	120	193
	10 P. M.	389	1,343	1,732	186	360	536
July 9	2 A. M.	410	778	1,088	18	115	133
	6 A. M.	283	424	707	0	4	4
	10 A. M.	212	2,969	3,181	0	0	0

DISCUSSION

The floating organisms or plankton in the sea drift with tide and current. Thus distribution depends partly on physical and chemical changes of the sea water, particularly in the case of planktonic amphioxus.

Change in oxygen content may affect the distribution of plankton and other living organisms, but since the oxygen content at Liuwutien is nearly saturated the distribution depends upon the temperature only. Since the temperature is nearly uniform throughout the day, it is not necessary to determine it in all collections. Changes in pH value and salinity are mainly due to the influx of fresh water either from inland or from rains. This finding was confirmed by observations made during the year.

Table 19 and text fig. 13 show many correlations in positive and negative directions. The number of young amphioxus collected shows inverse correlation with the intensity of sunlight. When sunlight was strong, young amphioxus had the tendency to burrow in the sand, and when the light became less bright they became more active and swam in the sea. After 10 P. M., when the intensity of light became weaker and the sea water darker, young amphioxus could be collected from both surface and bottom nets. At midnight the number of young amphioxus collected was at its height, decreasing gradually thereafter until no more amphioxus could be collected with the surface net and only 4 specimens with the bottom net. All these findings show that amphioxus is negatively phototropic, confirming the results of Parker's experiments.(37)

Aside from the effects of light intensity, the distribution of amphioxus and the frequency curve of the number of young amphioxus collected is governed also by the tide, which carries the water in between 4 and 10 P. M., bringing with it the young amphioxus from the eastern part of the amphioxus grounds. After the highest tide mark is reached, the young amphioxus are again carried away with the tide, so that the number of amphioxus at 6 A. M. is less than that at 6 P. M. Thus the frequency curve is not symmetrical.

The distribution of young amphioxus is influenced by the tide but not correlated with it. If it were, there ought to be a large number of young amphioxus at 10 A. M., when the tide is supposed to have reached the highest level and the volume of the total plankton collected in the net is largest. However, this was not the case, as the tide was found not to correlate with the distribution of young amphioxus.

The height of the tide and the total volume of the plankton showed a positive correlation. Both maximal and minimal points were apparently the same. When the tide comes, it usually brings in living floating organisms, and when it goes out, it carries them away. The total volume of each sample from the surface tow net was almost the same from each collection, but it was quite different among bottom samples. The total volume from the bottom net in each collection changed greatly during the day. From this observation we may conclude that the changes of sea water were limited only at the bottom and the planktonic organisms were likewise limited at that particular space and time. From this study it appears that the asymmetrical distribution of the number of young amphioxus as well as plankton is influenced by the tide. If the water decreases rapidly at midnight a large number of young amphioxus may be carried away from the grounds. Although the second tide of the day may carry some of them back again, it always occurs at noon when the young amphioxus confine themselves to the bottom.

GROWTH OF AMOY AMPHIOXUS

Considerable difficulty was encountered in the study of the growth of amphioxus, since they live at the bottom of the sea and no observation would be made directly. It was also difficult to maintain the natural conditions for the study of their growth in the laboratory. The present report deals with a statistical study of the sizes of amphioxus from which was computed the rate of growth of amphioxus.

Methods.—Sixty-three collections were made during 1931 and 1932. Ten monthly samples were obtained (except during July and August) in 1931, and the remaining 53 samples were collected at weekly intervals in 1932.

Collections of samples were made throughout the whole experiment in grounds between the town of Liuwutien and the Crocodile Islands. The collector and the fisherman who made the collections were maintained throughout the experiment. Each sample usually consisted of 5,000 cc of sand. It was taken in a tin bucket, and contained several hundreds of amphioxus. Separation by washing the sand from the amphioxus was done in the laboratory, care being taken to search for small individuals. After washing the amphioxus were carefully placed in large dishes with adequate clear sea water. Then they were narcotized with magnesium sulphate. Several drops of 10 per cent formalin solution was added subsequently in order to kill the amphioxus. The dead individuals were then moved to another dish containing 10 per cent formalin for preservation. In this way the amphioxus were easily fixed and preserved.

The individuals were classified into different groups according to that age, for the purpose of making a statistical study by the method used by Galton for separating the 19 kinds of beans in a mixed condition. The writer classified them into four age groups, namely: (1) The first-year amphioxus; that is, from the young presumably hatched in June and July to the end of the year, during a period of 6 months. (2) The second-year amphioxus; that is, those hatched in June and July of the preceding year. These amphioxus were from an age group of 6 months old to 1.5 years old. (3) The third-year amphioxus; those hatched in the year before the last, from 1.5 to 2.5 years old. (4) The fourth-year amphioxus; those from 2.5 to 3 years old. The amphioxus may die after attaining this age.

Second-year and third-year amphioxus may be divided into subclasses, such as (*a*) those without gonads, (*b*) those with little gonads, (*c*) those with large gonads, and (*d*) those with spent gonads.

After the classifying work was finished the amphioxus were bottled and carefully labeled. All the specimens were deposited in the Department of Biology, the National University of Amoy, Amoy.

Measurements of the individuals were made with a short meter stick in a small petri dish in a wet condition. One hundred thousand amphioxus were studied and measured for this work. About one out of ten individuals were collected in 1931, and the rest in 1932. The gonads were measured under a Greenough binocular microscope with the aid of an ocular micrometer. The lengths of the amphioxus represented the average lengths of the class. Dates of collection and other data for 1932 have been discussed in the section on ecology. Table 20 and text figs. 14 and 15 show the rate of growth of amphioxus, in 1931 and 1932; Table 21 shows the actual number of individuals collected in 1932, and Table 22 shows the number for each class in percentage. Text fig. 16 shows the growth of gonads in second-year and third-year amphioxus, and text fig.

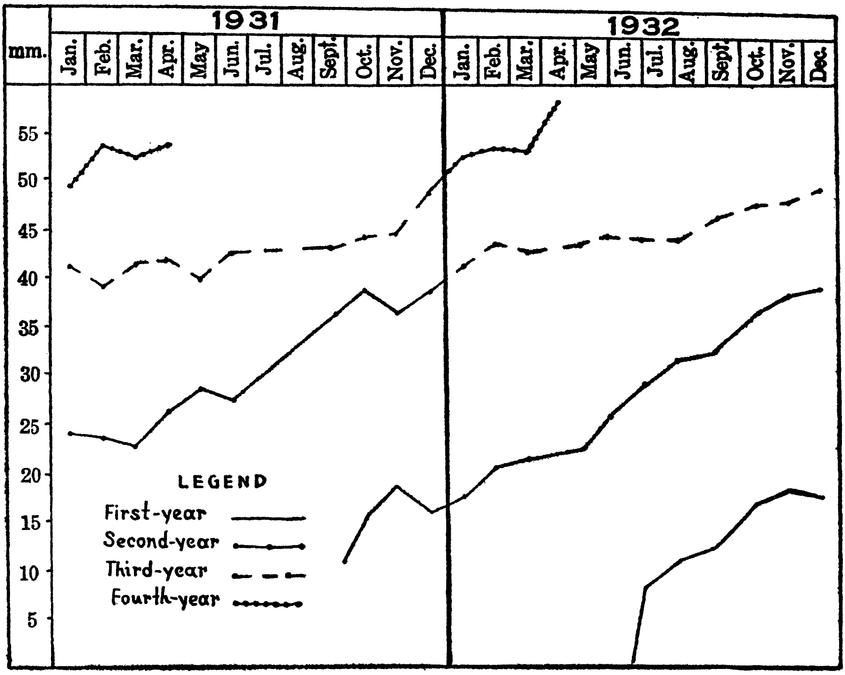


FIG. 14. Growth of amphioxus in 1931 and 1932.

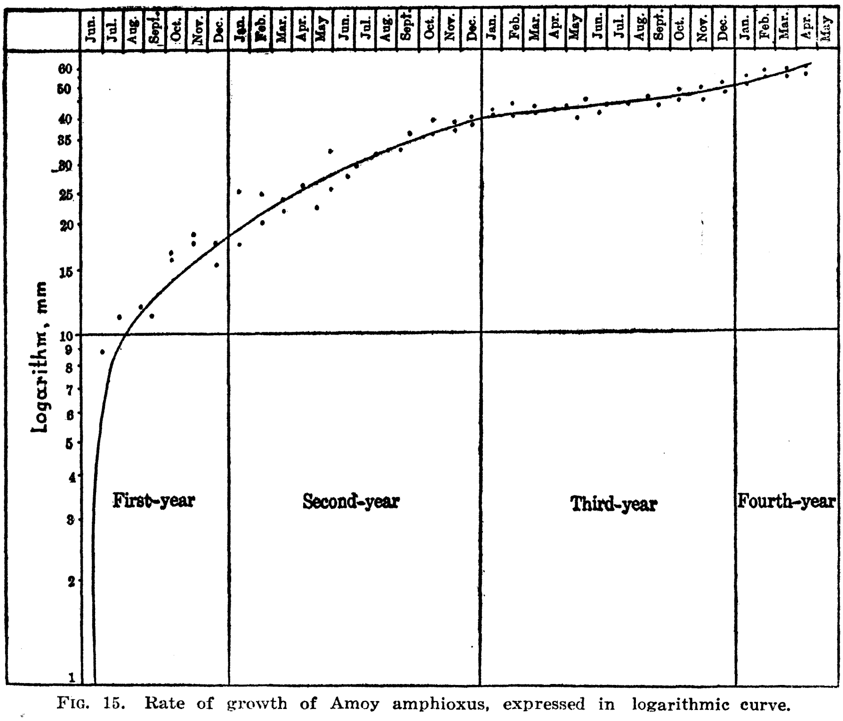


FIG. 15. Rate of growth of Amoy amphioxus, expressed in logarithmic curve.

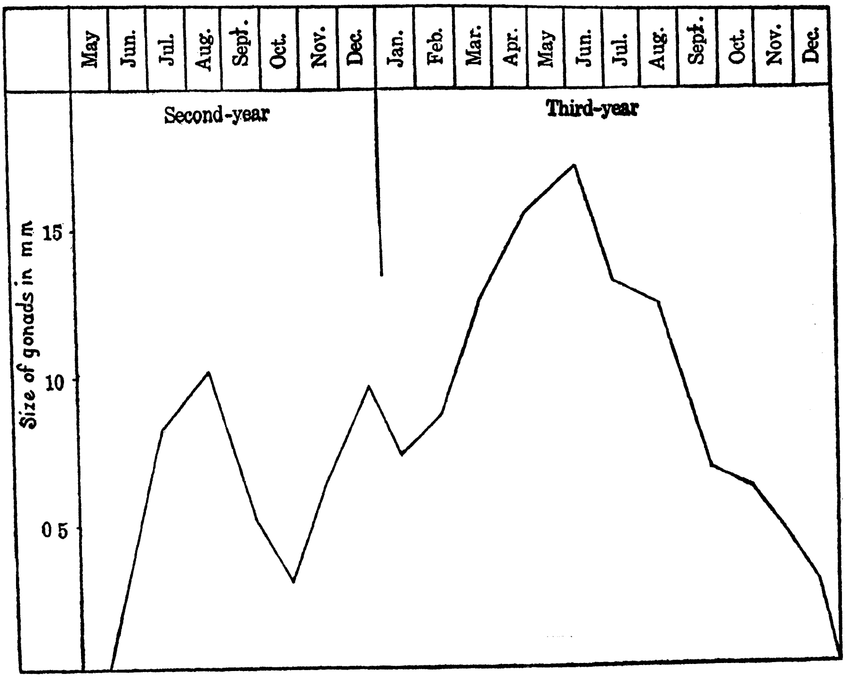


FIG. 16. Growth of gonads in second-year and third-year amphioxus.

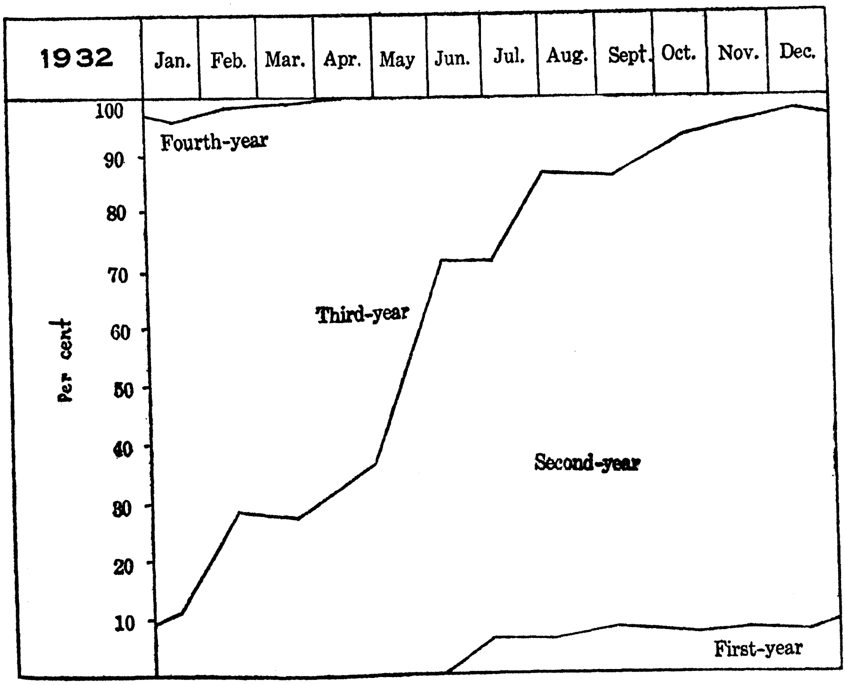


FIG. 17. Different aged amphioxus in each month, in per cent.

17 shows the ages by percentage of amphioxus caught in each month.

TABLE 20.—*The growth of amphioxus, in millimeters.*

Date of measurement.	Amphioxus.						Gonads.	
	Less than 6 months old.	1st-year.	2d-year.	3d-year.	4th-year.	Smallest.	2d-year amphioxus.	3d-year amphioxus.
1931								
January	-------	-------	24.64	41.32	49.36	-------	-------	-------
February	-------	-------	24.00	39.93	53.20	-------	-------	-------
March	-------	-------	22.95	41.58	52.10	-------	-------	-------
April	-------	-------	26.12	41.75	53.00	-------	-------	-------
May	-------	-------	28.42	40.01	-------	-------	-------	-------
June	-------	-------	27.49	42.55	-------	-------	-------	-------
July–August	-------	-------	-------	-------	-------	-------	-------	-------
September	-------	11.11	36.09	43.38	-------	-------	-------	-------
October	-------	16.13	38.91	44.59	-------	-------	-------	-------
November	-------	18.75	36.38	44.59	-------	-------	-------	-------
December	-------	15.63	38.75	48.18	-------	-------	-------	-------
1932								
January 1 to 31	-------	17.74	41.14	52.10	-------	8.2	-------	0.726
February 1 to March 9	-------	20.20	43.48	53.20	-------	8.0	-------	0.861
March 10 to 20	-------	21.31	42.81	52.86	-------	10.0	-------	1.258
March 31 to May 18	-------	22.06	43.61	57.00	-------	10.0	-------	1.588
May 19 to June 13	-------	25.19	44.87	-------	-------	12.0	-------	1.711
June 14 to July 13	8.80	29.12	44.30	-------	-------	3.0	0.806	1.322
July 14 to August 21	11.00	31.19	44.15	-------	-------	7.0	1.022	1.242
August 22 to September 30	11.70	32.10	45.61	-------	-------	7.0	0.504	0.684
October 1 to 31	6.71	36.11	47.27	-------	-------	6.0	0.278	0.604
November 1 to 30	18.07	37.78	47.49	-------	-------	11.0	0.662	0.794
December 1 to 31	17.54	38.40	49.20	-------	-------	8.0	0.950	1.260
	1st-year	2d-year	3rd-year	4th-year				

Breeding season.—The breeding season of amphioxus, as shown by the number of newly-hatched amphioxus obtained and by the size of the gonads measured, occurs twice a year; (*a*) from May to July, and (*b*) in December.

The size of the smallest individuals is given in Table 20, showing that the smallest of the small amphioxus collected monthly were collected in the middle of June, after which the individuals increased in size until the end of November. In December the smallest size of amphioxus (8 mm long) appeared again, another group of young amphioxus having been spawned at that time.

The determination of the breeding season on the basis of the finding of the smallest amphioxus is not a very accurate method, since the tiny individuals may be easily lost during washing. Therefore the size of gonads was also measured. The results appear to indicate more definitely the breeding season.

TABLE 21.—*Actual number of amphioxus of each class collected.*

1932	1st-year.	2d-year.				3d-year.			4th-year.
		Small.	Without gonads.	With small gonads.	With large gonads.	Without gonads.	With small gonads.	With large gonads.	
January 1 to 31		488				1,036	1,120	1,319	180
February 10 to March 9		1,329				637	1,174	1,546	76
March 10 to 30		1,134				716	919	1,235	39
March 31 to May 18		2,288				767	956	2,167	1
May 19 to June 13		3,804		339			317	1,258	
June 14 to July 13	893	5,122		5,151	2,193		119	3,685	
July 14 to August 21	902	5,942		2,469	2,299		425	1,105	
August 22 to September 30	1,139		7,746	3,052	304	46	1,542	175	
October 1 to 31	478		4,555	1,234		126	334		
November 1 to 30	471		3,703	1,646	8	50	214	2	
December 1 to 31	696		3,600	3,018	506		193	25	
Total	4,579	20,130	19,604	13,309	5,310	3,155	7,313	12,517	296

TABLE 22.—*Amphioxus of each class collected, in percentage.*

1932.	1st-year.	2d-year.				3d-year amphioxus.			4th-year.
		Small.	Without gonads.	With small gonads.	With large gonads.	Without gonads.	With small gonads.	With large gonads.	
January 1 to 31		10.9				25.2	27.3	32.2	4.4
February 1 to March 9		28.9				13.2	24.3	32.0	1.6
March 10 to 30		28.1				17.7	22.7	30.5	1.0
March 31 to May 18		37.0				12.3	15.5	35.1	0.1
May 19 to June 13		65.8		5.9			5.5	21.8	
June 14 to July 13	6.6	37.8		11.4	16.1		0.9	27.2	
July 14 to August 21	6.2	45.4		18.9	17.6		3.3	8.6	
August 22 to September 30	8.1		55.3	21.8	2.2	0.3	11.0	1.3	
October 1 to 31	7.1		67.7	18.3		1.9	5.0		
November 1 to 30	7.8		61.0	27.0	0.08	0.8	3.5	0.03	
December 1 to 31	8.7		44.9	37.7	6.0		2.4	0.3	

The first-year amphioxus had no gonads. But the second-year individuals had little gonads at the end of May which enlarged quickly in June and reached their maximum size in July. After July many amphioxus were spawned, and as a result the average size of the gonads decreased. Beginning with December the gonads became enlarged again, and decreased again in January of the following year. The degree of shrinkage in this period was very slight, since only a few amphioxus were spawned in December and January.

The gonads of the third-year amphioxus became larger and larger and reached their maximum size in May. Then they decreased gradually and reached their minimum in December. During this decreasing process numerous amphioxus were born. The fourth-year amphioxus was the largest but contained no gonads; at about that age the animal presumably dies.

From the study of the size of gonads we may infer that the amphioxus had three spawning seasons during the period under study. The first was in June and July, 1931, when the amphioxus was 1 year old. In this period a moderate number of amphioxus were born. The second spawning period occurred in December and January, when the amphioxus was 1.5 years old, and in this period relatively few amphioxus were born. The third occurred from May to December, when the amphioxus was 2 to 2.5 years old, and in this period numerous amphioxus were born.

The growth of amphioxus.—The growth data is shown in Table 20 and text fig. 14. All measurements in the table represent averages of numerous individuals (Table 21) collected.

First-year amphioxus.—In June, 1932, several hundreds of small amphioxus, measuring around 8.8 mm, were collected. These grew to a length of 17.54 mm by the end of the year, increasing their size by 8.74 mm between June and December. More or less the same rate of growth obtained for the first-year amphioxus of 1931.

Fortunately I also collected many very young amphioxus by tow net in July, 1933, as mentioned in connection with the vertical distribution of the young amphioxus.

The specimens collected were from the 1-gill stage to the 12-gill stage, and had a length of about 6 mm. Thus the amphioxus grew fastest during the first few weeks and reached a length of 8.8 mm. Therefore the rate of growth (text fig. 15) was highest in the first few weeks and slowed down before the end of the first half year.

Amphioxus collected in December were smaller than those collected in November, both in 1931 and in 1932, apparently due to the appearance of newly-hatched amphioxus in this period. There was no way of separating the new individuals from the older ones, since the breeding season for the third year amphioxus was continuous from May to the end of the year as mentioned before. Moreover the young individuals, born from the second-year and the third-year amphioxus were similar and could not be distinguished from one another.

Second-year amphioxus.—The second-year amphioxus in 1932 were born in June, 1931. They grew from 17.74 mm to 38.4 mm in 12 months, an increase of 20.66 mm. When the amphioxus reached a length of 29.12 mm the gonads began to appear, and when they reached a length of 31.19 mm the gonads reached maturity. The records for 1931 were very much the same, except that the size was slightly greater in January.

Third-year amphioxus.—The second-year amphioxus of 1931 became the third-year individuals in 1932. They grew to a length of from 41.14 to 49.2 mm in this year, an increase of 8.06 mm. Some of the amphioxus of this age group spawned at the beginning of the year, and therefore had no enlarged gonads. However, most of them contained small gonads while many contained large gonads. In the middle of the year the amphioxus collected contained large gonads which were gradually discharged before the end of the year. The record obtained in 1931 was exactly the same as that for 1932.

Fourth-year amphioxus.—At the end of the third year all the gonads were discharged, and only a few of the individuals were able to live up to the beginning of the next year. These individuals were called the fourth-year amphioxus. They usually increased in length to 52.86 (1932) or 53 mm (1931), although one or two of them actually reached a length of 57 mm.

Old age of amphioxus.—Amphioxus were found to die from July of the third year to April of the fourth year. Since the young amphioxus were born continuously from June to the end of the year the life of amphioxus was from 2 to 3 years.

Seasonal distribution of different aged amphioxus.—The distribution of the different age groups of amphioxus in each month was quite interesting. The first-year amphioxus increased its percentage gradually from June (6.6 per cent) to the end of the year (8.7 per cent). The second-year amphioxus were not numerous in January (10.9 per cent), but gradually increased up to the beginning of May (37 per cent), and suddenly increased at the end of May (72.7 per cent). The percentage continued to increase up to the end of the year (88.6 per cent). The third-year amphioxus were numerous in the beginning of the year (84.7 per cent) and decreased, as the second-year amphioxus increased, to 2.7 per cent by December. The fourth-year amphioxus were relatively few both in number of individuals and in percentage. All of them disappeared in April.

In short, the third-year amphioxus was predominant in the first part of the year, the second-year amphioxus was slightly predominant in the middle and predominant in the latter part of the year. The first-year and the fourth-year individuals were relatively few.

Growth and shape of amphioxus.—The shape of the young amphioxus is different from that of the adult. At a length below 20 mm the body is much broader in the pharyngeal region, and narrower at the posterior, and becomes narrower in the pharyngeal region in proportion and almost uniform in size from the anterior to the posterior end when it grows larger.

AMPHIOXUS FISHERIES

The phrase "amphioxus fisheries" was first introduced by Prof. S. F. Light. He described the fishing processes and published a few photographs. The present paper will give more detailed information about this industry, containing essentially the information contained in an article published in Chinese by the present writer and T. Y. Chen, and, in addition, many photographs relative to the processes of fishing amphioxus.

The history of amphioxus fisheries and the fishing ground were described in earlier parts of this paper; the present section covers the following: (*a*) fishing villages; (*b*) fishing equipment; (*c*) fishing processes; (*d*) fishing period; (*e*) annual production; (*f*) methods of cooking amphioxus; and (*g*) analysis and food value of amphioxus.

FISHING VILLAGES

Ten small fishing villages are present on the coast of the mainland, at Liuwutien and vicinity. About 7,300 inhabitants are scattered in these villages, of whom 610, representing 8.36 per cent of the total population, are engaged in fisheries. Among the fishermen 418 individuals, 68.52 per cent, are amphioxus fishermen, showing that this fishery is an important one in these villages. Usually two men are working on one fishing boat, so that 209 fishing boats operate in this region. The distribution of the above records in the ten villages is given in Table 23.

TABLE 23.—*The villages, fishermen, and fishing boats engaged in amphioxus fisheries.*

Village.	Total population	Fishermen.	Amphioxus fishermen.	Amphioxu fishing boats.
Liuwutien	1,100	100	50	25
Pu Nang	900	150	100	50
Lu An	1,500	70	24	12
Nang Pien			28	14
Shan Tao			16	8
Hsu Tsu	1,700	200	24	12
Hoo Ping			132	66
Au Tsu	1,500	40	12	6
Chen Tsu	200	30	20	10
Kuei Yuan	400	20	12	6
Total	7,300	610	418	209

FISHING EQUIPMENT

The amphioxus fishing equipment is quite simple and primitive. It consists of (*a*) fishing boat, (*b*) dredge, and (*c*) washing apparatus.

Fishing boat.—The fishing boat is very much like an ordinary *sampan,* 18 feet long, 5 feet wide, 2.5 feet deep, 1.5 feet at the bow end, and 5 feet at the stem end. The capacity of the boat is about 1,000 pounds. Two sculls at the stem are 15 feet long. An elongated stone weighing more than 15 pounds, with a long cord attached, is used as a sinker. The boat, locally made, costs about 40 Chinese dollars, and lasts for 4 to 5 years.

Dredge.—The dredging apparatus may be divided into two kinds: light and heavy. Both are of the same style.

The lighter dredge consists of an iron scoop resembling a shovel blade and a bamboo stick, having a total weight of 7.3 pounds. The two sides of the scoop are each 12.5 inches long; the sharp edge is 13 inches and the base near the bamboo is 10 inches long. The bamboo stick, 8 feet and 2 inches long, is fastened to the base of the scoop at an angle of 75°. This lighter dredge is used only in very shallow water during ebb tide.

The heavier dredge consists of three parts; namely, an iron scoop, a bamboo stick, and a long cable consisting of two pieces of small rattan twined together. The two sides of the scoop are each 14.5 inches long, the sharp edge being 17 inches, and the base 15.5 inches long. The bamboo stick is 12 feet 3 inches long, while the cable is 10 meters long. Between the bamboo stick and the scoop a short wooden stick is used to fasten them together, and sometimes another iron chain is also used between the scoop and the bamboo stick, thus securely holding the scoop. The cable is fastened to the other end of the bamboo. The bamboo stick is filled with sand to provide adequate weight to the dredge to sink to the bottom of the sea. This heavy dredge can catch amphioxus at any depth, even during the flood tide.

These apparatus can be used for 2 years. The lighter one costs 3 Chinese dollars and the heavier one, 6 Chinese dollars.

Washing apparatus.—Seven instruments are used for washing amphioxus. They are: (*a*) a bamboo floater about 3 to 4 cubic feet; (*b*) a round wooden plate, about 3 feet in diameter; (*c*) a bamboo bowl with a long handle; (*d*) two wooden blocks, 5 by 7 inches; (*e*) a small, deep, split-bamboo basket, 19 inches in diameter and 9 inches deep, with two small wooden handles on the sides; (*f*) a large, shallow, split-bamboo basket, 25 inches in diameter and 6.5 inches deep, also with two handles; and (*g*) a wooden vessel, about 10 inches in diameter.

FISHING METHODS

Upon reaching the fishing ground the boat is anchored by dropping the stone sinker, the cord of which is fastened to the side of the boat. The boat is thus prevented from drifting with the tide. Subsequently a bamboo floater with a wooden plate is put on the surface of the water on the other side of the boat. One of the fishermen holds a bamboo stick of the dredge at an angle of 45° to the holder (Plate 1, fig. 1). Then he throws the dredge on the surface of the water at an angle of 30° to 40° in front of the boat (Plate 1, fig. 2). When the scoop reaches the surface, it glides forward a little farther (Plate 2, fig. 1), increasing the towing distance on the ground. The trick is not easy for an ordinary man. The scoop can reach the sand by its own weight when towed slightly, otherwise a fisherman would have to propel the boat backward for a few feet in order to force the scoop into the sand.

When the scoop is about to be lifted, it is towed in the sand for a distance of 5 to 10 feet. Once the scoop is away from the sand, the fisherman strives to keep it in a horizontal position (Plate 3, fig. 1). The lifting process is very gradual, so that the amphioxus cannot be washed away by the water. When the scoop is out of water the contents are quickly poured on the floating round board (Plate 3, fig. 2). These processess are repeated many times during the ebb tide, until enough amphioxus are collected.

The assistant fisherman, by means of the bamboo bowl, continuously washes (Plate 3, fig. 1) the sand away from the round board with sea water. When the water is poured on the surface of the sand, all the amphioxus burrow into the bottom of the sand; therefore only the surface sand is washed away into the sea. When most of the sand is washed away, the amphioxus on the board, with whatever amount of sand is left on them, are placed in the boat.

After sufficient amphioxus are captured, or when the tide is unfavorable for fishing amphioxus, the fisherman returns to the beach (Plate 4, fig. 1), where washing can be done more carefully.

The amphioxus and the sand are taken out of the boat with two wooden blocks into a small dip basket. (Plate 4, fig. 2). By rotating the basket on the surface of the water (Plate 5, fig. 1) the fine sand and the small amphioxus are made to pass through the bamboo slits into the water, until only the coarse sand, mollusks, and amphioxus are left. These are now transferred into a large bamboo tray for further separation. The bamboo tray is moved up and down and back and forth many times to cause the amphioxus to float to one side and the sand particles to sink to the bottom of the basket. Then the amphioxus are separated and placed into a wooden vessel for marketing.

THE FISHING SEASON

Young amphioxus float in the sea as planktonic organisms. On reaching maturity they migrate down and burrow into the sand, where they remain the rest of their lives. The fishing season begins between August and October. Numerous boats appear in the fishing grounds from December to January of the following year. The last period of the fishing season is from February to April, so that amphioxus fishing is carried on for 9 months of the year. The daily fishing period is limited by the tide, lasting 4 hours during receding tide.

It is fortunate that fishing for amphioxus is suspended during the breeding season, as this practice reduces the danger of depletion. During the breeding season the amphioxus do not taste good, due to the lack of oil content, and, however, at this time the larger fishes and sharks, which have a higher market price, are available. Also, during this season the large majority of the people are busy in the rice fields.

ANNUAL PRODUCTION

The annual production of amphioxus is 55,845 catties or 74,460 pounds (35 tons), with a value of 11,727.45 Chinese dollars. This small sum represents a large income for these 10 small villages at Liuwutien and its vicinity. If one pound of fresh amphioxus, as estimated by Light, contains about 2,500 individuals, 1,526,430,000 individuals are captured for food annually.

The above figures are taken from weekly observations during 1932. The number of fishing boats and the market prices of amphioxus are shown in Table 24.

Table 24 shows the daily variation and monthly average of prices and boats. The maximum number of fishing boats in one day occurred in January, when 92 boats were observed. The daily average of 39.2 boats was observed in January and only 1 boat in June. The market price was from 16 cents to 32 cents Chinese currency per catty, and 21 cents per catty on the average.

No tax has been imposed on this industry. The average quantity of amphioxus captured by a fishing boat in one day is 10 catties. It is worth about 2 Chinese dollars, which is a good income for the natives.

The fishing markets are distributed in the fishing villages and in the Amoy market during the cold season. At Liuwutien there is only one old small amphioxus shop, the one shown in Plate 5, fig. 2. The amphioxus are also dried and sent to Java and Singapore for the emigrants from Amoy and its vicinity.

METHODS OF COOKING AMPHIOXUS

Amphioxus has no scale and no bone, and its internal organs need not be removed before cooking. The amphioxus must be washed with fresh water in order to reduce its salt content, and then cooked with egg, beef, or pork. The dried amphioxus are prepared above a small flame with a little oil in a pan. Fresh amphioxus may be kept for a long time. The dried amphioxus taste much better than the fresh. Dried amphioxus usually costs 1 Chinese dollar a pound.

TABLE 24.—*Market prices of amphioxus and number of fishing boats in 1932.*

Date.		Market price, in cents.		Number of fishing boats.	
		Each date.	Average for the month.	Each date.	Average for the month.
January	2	20	22.4	92	39.2
	9	28		8	
	16	22		54	
	22	22		18	
	29	20		24	
February	4	25	26.5	3	6.5
	11	24		5	
	18	32		3	
	25	25		15	
March	3	32	26.0	1	2.8
	10	22		10	
	17	------		0	
	24	25		2	
	31	25		1	
April	7	25	25.0	3	6.5
	14	25		10	
May	5	------	23.3	0	1.6
	12	22		4	
	19	25		2	
	24	22		2	
	27	------		0	
	30	25		2	
July	14	------	18.0	0	1.7
	23	18		2	
	25	------		0	
	28	18		8	
August	1	20	17.6	10	5.8
	4	20		6	
	8	16		5	
	11	------		0	
	15	------		0	
	18	16		16	
	22	16		15	
	25	------		0	
	29	------			
September	1	18	19.2	12	27.8
	8	16		40	
	15	22		42	
	22	18		42	
	29	22		3	
October	6	22	20.0	50	27.5
	13	20		15	
	20	18		45	
	27	------		0	

June	2	20	19.0	2	1.0	November	6	18	18.0	53	35.7
	14	----------		0			10	18		15	
	17	----------		0			17	18		25	
	20	----------		0			24	18		31	
	23	18		5		December	1	17	17.8	35	26.6
	27	----------		0			8	17		35	
	30	----------		0			15	17		30	
July	4	----------	18.0	0	1.7		22	22		15	
	8	----------		0			29	16		18	

ANALYSIS AND FOOD VALUE OF AMPHIOXUS

The food value of amphioxus compares with that of other food fishes. It produces 1,859 to 2,122 lbs. / cals. per 100 grams. The fat content is rather low, but the iodine content of the fat is quite high. Protein is also high. The residue is quite high, three to four times that of ordinary fishes. Since the amphioxus are washed with sea water and then dried in the sun for analysis, foreign particles are usually mixed with the amphioxus, such as sodium chloride, potassium chloride, and silicon dioxide. Phosphorus is relatively low, while sulfate is relatively high, especially in the summer. Iron and calcium, which are very important in food fishes, are quite high.

The seasonal influence on amphioxus analysis is very much the same as in other fishes. The fat content is lower in summer, when the gonads of amphioxus are fully grown. The fat content is higher in the fall when the gonads are relatively small. Therefore people do not like to eat amphioxus in the breeding season, as I mentioned before. Residue and heat value are very much the same in different seasons. Table 25 gives a chemical analysis of Amoy amphioxus.

TABLE 25.—*Chemical analysis of Amoy amphioxus* (*Lau, 1934*).

Content.	For 100 grams of amphioxus.		Calculated from 100 grams of protein.	
	Summer.	Fall.	Summer.	Fall.
Humidity per cent	7.85	11.56	----------	----------
Heat value	21.22	18.59	29.66	26.88
Fat per cent	2.12	3.98	2.98	5.75
Iodine value	106.60	101.6	----------	----------
Protein grams	71.16	69.18	100.00	100.00
Ash per cent	14.45	13.79	20.31	19.93
SiO_2 per cent of ash	12.73	19.53	1.208	1.819
Fe_2O_3 per cent	4.74	5.28	0.673	0.736
CaO do	2.75	3.72	0.399	0.530
MgO do	4.48	4.03	0.549	0.485
SO_3 do	1.94	1.83	1.350	1.296
K_2O do	13.53	16.33	2.281	2.703
Na_2O do	28.91	24.54	4.355	3.629
Cl do	29.82	23.74	6.054	4.729
P_2O_5 do	11.69	13.13	1.038	1.143

DISCOVERY OF QUAMOY AMPHIOXUS GROUND, IN THE VICINITY OF AMOY

Amphioxus was recently discovered at the north sea of Quamoy Island in the vicinity of Amoy. The grounds are irregular in shape and rather small compared with those to the North of Amoy Island. Text fig. 18 shows the Quamoy amphioxus ground.

Twenty-seven samples were collected from this ground (about 1.5 square miles) and its vicinity. Sixteen of these samples were found to contain amphioxus. The conditions of the grounds are very much the same as those of the Amoy grounds.

The depth of these amphioxus grounds is from 0.5 to 3.5 meters, with an average of 1.9 meters. Therefore, these grounds are much shallower than the Amoy amphioxus grounds. The number of individuals found at each station varies from 6 to 100, with an average of 54 individuals, which is less than that for Amoy. Since the amphioxus are so much less numerous the fishery is not developed and no people are interested in it. Table 26 shows data on bottom samples of the Quamoy amphioxus grounds, and Table 27 shows data for bottom samples collected from the vicinity of the Quamoy amphioxus grounds.

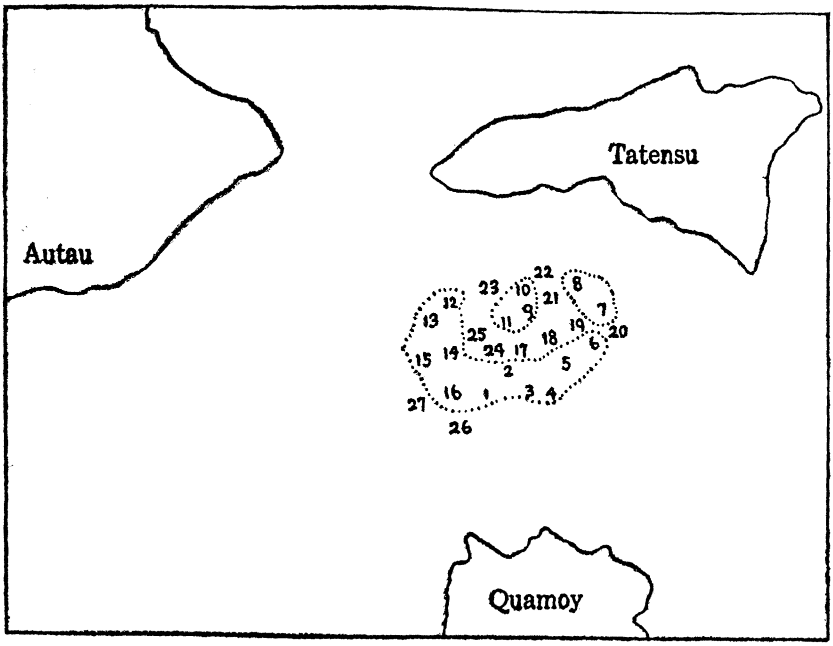


FIG. 18. Map of Quamoy amphioxus ground, showing the station numbers.

The origin of these amphioxus grounds is easily understood, since they are just outside of the Amoy amphioxus grounds. The larval and the postlarval stages of young amphioxus of

TABLE 26.—*Data on the bottom samples collected from the Quamoy amphioxus grounds.*

Station.	Depth.	Number of amphioxus.	Sizes of bottom particles.							
			Cannot be sifted through sieve 12.	Can be sifted through sieve—						
				12	18	30	60	90	100	120
	m.		*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
1	1.0	37	400	250	175	340	50	4	2	4
2	1.0	79	325	210	175	425	57	2	2	5
3	1.0	51	120	200	230	560	32	2	1	5
4	1.5	74	225	255	450	260	30	2	2	4
5	0.5	11	375	240	160	410	28	2	1	7
6	2.0	70	60	160	330	575	20	2	1	4
7	2.5	50	6	140	320	625	25	2	1	5
8	3.0	6	75	150	340	550	52	10	5	12
9	1.0	54	40	160	340	600	20	1	1	3
10	2.0	40	35	130	350	600	17	2	1	4
11	3.5	16	40	160	375	570	28	5	2	5
12	1.5	13	225	365	385	50	23	8	2	8
13	3.5	100	130	300	375	350	32	8	4	7
14	2.0	100	28	217	300	435	45	5	3	10
15	1.0	78	33	240	420	413	30	6	2	4
16	3.0	86	39	200	340	533	20	7	3	4
Total	30.0	865	2,156	3,377	4,870	7,491	509	68	43	87
Average	1.8	54	135	211	304	468	31	4	3	5
Per cent	--------	--------	11.16	18.1	26.2	40.3	2.6	0.4	0.3	0.5

TABLE 27.—*Data on the bottom samples collected from the vicinity of Quamoy amphioxus ground.*

[No amphioxus were dredged from this ground.]

Station.	Depth.	Sizes of bottom particles.							
		Cannot be sifted through sieves 12.	Can be sifted through sieve—						
			12	18	30	60	90	100	120
	m.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
17	2.0	400	80	105	280	24	7	6	340
18	1.3	600	100	90	200	70	3	5	300
19	4.0	75	430	120	175	70	10	10	450
20	4.0	100	190	245	205	28	1	1	500
21	5.0	138	350	205	140	43	6	9	370
22	3.0	5	75	180	880	30	4	1	9
23	4.3	85	310	619	145	80	3	3	7
24	3.0	100	213	345	450	23	4	2	23
25	3.5	75	190	290	70	91	2	2	600
26	6.0	275	250	100	270	50	6	5	450
27	10.0	260	210	285	300	70	7	6	360
Total	46.1	2,113	2,398	2,594	3,115	579	53	50	3,409
Average	4.2	192	218	236	283	53	5	5	310
Per cent	--------	14.8	16.7	18.1	21.7	4.1	0.4	0.4	23.8

Amoy easily drift to the north of Quamoy. When the young amphioxus reach the Quamoy sand, they burrow in and reproduce there.

From this discovery we can expect that there will be more and more amphioxus grounds along the coast of Fukien and its vicinity, where the conditions are similar to those of the Amoy and Quamoy amphioxus grounds.

LITERATURE CITED

1. ASSHETON, R. The geometrical relation of the nuclei in an invaginating gastrula (e. g. amphioxus) considered in connection with cell rhythm and Driesch's conception of entelechy. Archiv. Entwick. **29** (1910) 44–78.
2. BLES, E. J. Notes on the plankton observed at Plymouth during June, July, August, and September, 1892. Journ. Marine Biol. Assoc. n. s. **2** (1892) 340–343.
3. BORING, A. M., and H. L. LI. Is the Chinese amphioxus a separate species? Peking Nat. Hist. Bull. (3) **6** (1932) 9–18.
4. CHEN, T. Y. On a hermaphrodite specimen of the Chinese amphioxus. Peking Nat. Hist. Bull. (4) **5** (1931) 11–16.
5. CHEN, T. Y. Notes on the history of Amoy amphioxus in southern Fukien. Marine Biol. Stat. Pop. Ser. Univ. Amoy **1** (1936) 1–10. In Chinese.
6. CHEN, T. Y., and T. G. CHIN. A survey of amphioxus fisheries at Amoy. Construction of China, Nanking. (3) **7** (1933) 115–123. In Chinese.
7. CHIN, T. G. Notes on the seasonal distribution of polychaete annelids of Amoy and its vicinity. China Journ. (2) **30** (1936) 117.
8. CHIN, T. G. Diatoms in the stomachs of marine animals from Amoy and its vicinity. Philip. Journ. Sci. **70** (1939) 403–410.
9. EDINGER, L. Einiges vom "Gehirn" des Amphioxus. Anta. Anz. Jena (1906) 417–428.
10. FRANZ, V. Systematische Revision der Akranier. Jenaische Zeitschrift für Naturwissenschaft **58** (n. s. **51**) (1922) 369–452.
11. FRANZ, V. Haut, Sinnesorgane und Nervensystem der Akranier. Ibid. **59** (n. s. **52**) (1923) 202–526.
12. FRANZ, V. Morphologische und ontogenetische Akranierstudien über Darm, Trichter, Zolomderivate, Muskulatur und Bindegewebsformationen. Ibid. (n. s. **54**) (1925) 407–468.
13. FRANZ, V. Über subchordale Organsysteme von Branchiostoma. Ibid. **62** (n. s. **55**) (1926) 402–462.
14. GIBSON, H. O. S. The Cephalochorda. "Amphioxides." Trans. Linn. Soc. London II **13** (1909) 212–254.
15. GOLDSCHMIDT, R. Amphioxides and amphioxus. Zool. Anz. **30** (1906) 443–448.
16. GRAY, J. E. Description of a new species of amphioxus from Borneo. Proc. Zool. Soc. London **5** (1847) 35, 36.
17. GRENACHER, H. Beiträge sur näheren Kenntniss der Muskulatur der Cyclostomen und Leptocardier. Zeitschr. f. Wiss. Zool. **17** (1867) 1–24.

18. GÜNTHER, A. Pelagic fishes. Challenger Report Zool. 31 (1889) 42–44.
19. HARTMANN, E. The conditions prevailing at the amphioxus fishing grounds near the Island of Amoy. First annual Rep. Mar. Biol. Assoc. China (1932) 93–96.
20. HATSCHEK, B., and J. TUCHEY. The amphioxus and its development. MacMillan & Co. (1893) 1–181.
21. HERDMAN, W. A. Amphioxus. Cambridge Nat. Hist. 7 (1904) 112–138.
22. KOO, S. Y. Measurements on velar tentacles of the Amoy amphioxus. Nat. Sci. Bull. Univ. Amoy 19 (1935) 175–178.
23. LEIBER, A. Ueber Bau und Entwicklung der weiblichen Geschlechtsorgane des Amphioxus lanceolatus. Zool. Jahr. (1903) 1–41.
24. LIGHT, S. F. Amphioxus fisheries near the University of Amoy, China. Science 58 (1923) 67–70.
25. LIGHT, S. F. On amphioxus and the discovery of amphioxus fisheries in China. China Journ. (4) 1 (1923) 346–359.
26. LING, J. G. Amphioxus fisheries at Liuwutien. First annual Rep. Fishery Assoc. China 1 (1934) 7–9. In Chinese.
27. LIU, C., and W. T. SHÈ. A chemical analysis of the sea water of Amoy Harbour. Nat. Sci. Bull. Univ. Amoy (2) 1 (1935) 139–156.
28. LÖNNBERG, E. Leptocardii. In Bronn's Klassen und Ordnungen des Tierreichs 6 (1924) 99–249.
29. LOU, K. S. A chemical analysis of Amoy amphioxus. A graduate thesis from the Department of Chemistry Univ. of Amoy (1934) 1–41. Unpublished.
30. LOU, T. H. Note sur la larve d'Amphioxus recueillie á Tchefou. Contr. Inst. Zool. Nat. Acad. Peiping 3 (1936) 115–124.
31. MACBRIDE, E. W. Notes on the formation of the germinal layers in amphioxus. Proc. Cambridge Phil. Soc. 9 (1896) 151–153.
32. MACBRIDE, E. W. The early development of amphioxus. Q. J. M. S. 40 (1897) 589–612.
33. MORGAN, T. H. The number of cells in larvae from isolated blastomers of amphioxus. Archiv f. Entwick. d. Organ. 3 (1896) 269–294.
34. ORTON, J. H. On a hermaphrodite specimen of amphioxus, with notes on experiments in rearing amphioxus. Journ. Marine Biol. Assoc. 10 (1915) 506–511.
35. PARKER, G. H. The stimulation of the integumentary nerves of fishes by light. Amer. J. Physiol. 14 (1905) 413–420.
36. PARKER, G. H. The origin of the lateral eyes of vertebrates. Amer. Naturalist 42 (1908) 601–609.
37. PARKER, G. H. The sensory reactions of amphioxus. Proc. Amer. Acad. Arts & Sci. 43 (1908) 415–455.
38. PING, C. Zoological notes on Amoy and its vicinity. Bull. Fan Mem. Inst. Biol. (8) 1 (1930) 125–142.
39. RATHBUN, MARY J. New and rare Chinese crabs. Lingn. Sci. Journ. 8 (1929) 75–126.
40. REEVES, C. D. Some observations of the behavior of amphioxus. Ginling College. Nanking (1931) 29–34.

41. ROLPH, W. H. Untersuchungen über den Bau des Amphioxus lanceolatus. Morpholog. Jahr. 2 (1876) 1–80.
42. TCHANG, SI, and K. C. KOO. Description of a new variety of Branchiostoma belcheri Gray from Kiaochow Bay, Shangtung, China. Contr. Inst. Zool. Nat. Acad. Peiping (4) 3 (1936) 76–114.
43. WILLEY, A. Amphioxus and the ancestry of the vertebrates. MacMillan & Co. (1894) 1–316.
44. ZAPF, K. Beiträge zur Oogenese des Branchiostoma lanceolatum. Zool. Jahr. f. Abt. Morphol. (1932) 223–262.
45. ZARNIK, B. Über die Geschlechtsorgane von Amphioxus. Ibid. (1904) 1–86.

ILLUSTRATIONS

PLATE 1

FIG. 1. Fisherman holding his dredge in position before dredging. The town of Liuwutien is in the background.

2. Throwing the dredge at an angle of 45° to the boat.

PLATE 2

FIG. 1. The dredge gliding a little farther on the surface of the water. Crocodile Island is in the background.

2. The dredge reaches the bottom.

PLATE 3

FIG. 1. Lifting the dredge. The assistant fisherman is washing the amphioxus on the wooden disc.

2. Pouring the sand and the amphioxus on the wooden disc.

PLATE 4

FIG. 1. Fishing boats arriving at the beach.

2. Amphioxus and sand are put into the bamboo basket for separating.

PLATE 5

FIG. 1. Separating the amphioxus in a basket.

2. The amphioxus market at Liuwutien. The writer is buying a catty of fresh amphioxus.

TEXT FIGURES

FIG. 1. The regenerated tail.

2. The branched cirrus.

3. The abnormal gonads. *a*, lateral view; *b*, ventral view.

4. Map of Amoy and its vicinity, showing the currents in ebb tide (→), flood tide (→), and fresh water (→) from inland; the depth of the sea in meters; and the Amoy and Quamoy amphioxus grounds.

5. Map of Amoy amphioxus grounds, showing the station numbers and the fishing villages.

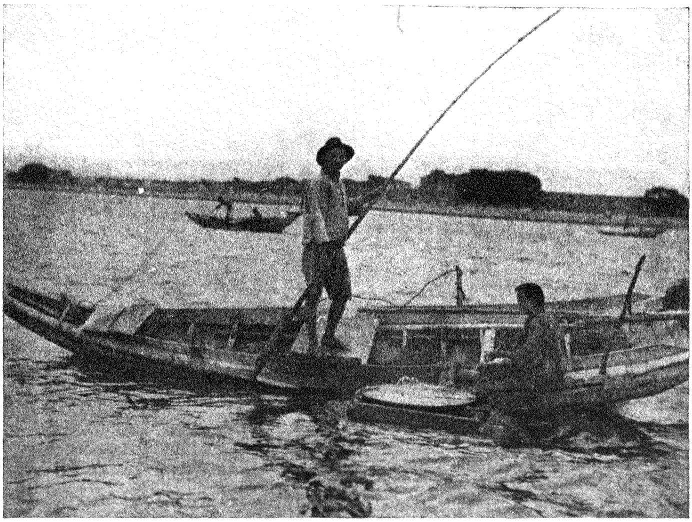
6. Map of Amoy amphioxus grounds, showing the distribution of the number of amphioxus in a 1,000 cc sand sample in each station.

7. Differences between bottom samples with and without amphioxus, collected from amphioxus grounds and their vicinity. 0 represents the largest particles of sand that cannot be sifted through sieve 12. 12, 18, 30, 60, 90, 100, and 120 represent particles that can be sifted through the corresponding sieve. 120 is the finest sieve.

8. Section of the sea from Chipbee through Crocodile Island to Liuwutien, showing the nature of the bottom and the distribution of amphioxus.

FIG. 9. Sections of the sea in the amphioxus grounds and their vicinity, showing depth and bottom conditions from which the directions of water currents are plotted.

10. Correlation between the large particles and carbon dioxide produced.
11. Temperature and dissolved oxygen content at Liuwutien in 1932.
12. Salinity and pH value at Liuwutien and Kulangsu; and rainfall at Amoy in 1932.
13. The vertical distribution of young amphioxus, and other related phenomena.
14. Growth of amphioxus in 1931 and 1932.
15. Rate of growth of amphioxus, expressed in logarithmic curve.
16. Growth of gonads in second-year and third-year amphioxus.
17. Different aged amphioxus in each month, in per cent.
18. Map of Quamoy amphioxus grounds, showing the station numbers.



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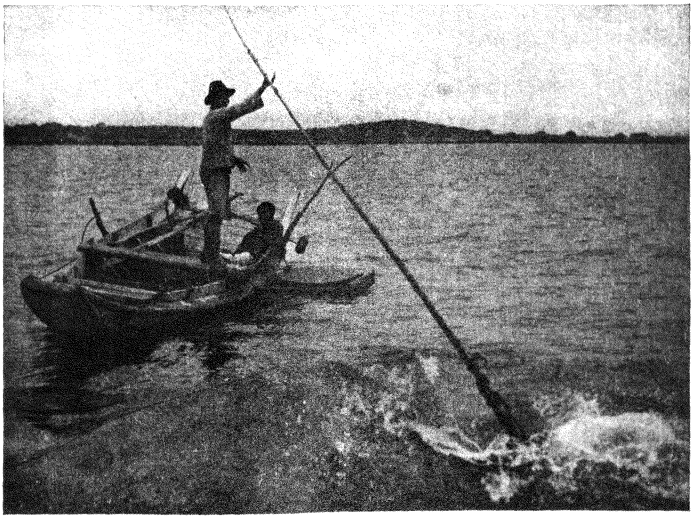

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PLATE 1.

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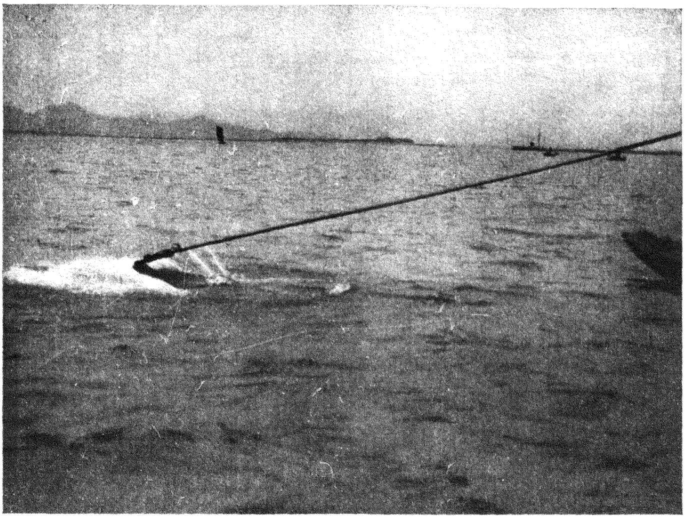

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PLATE 2.

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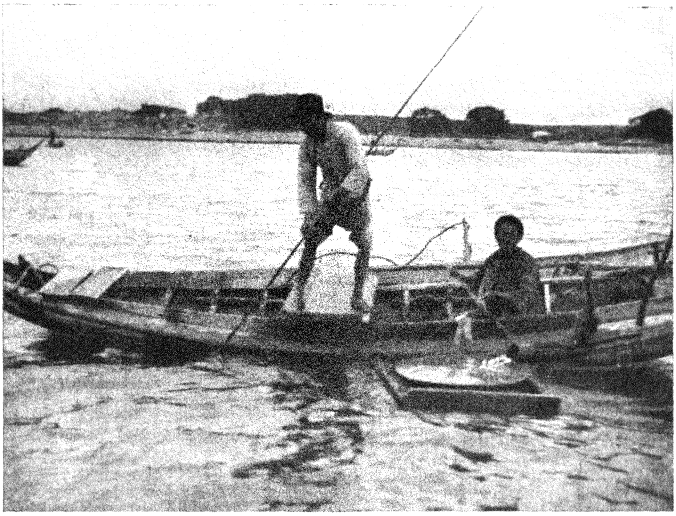

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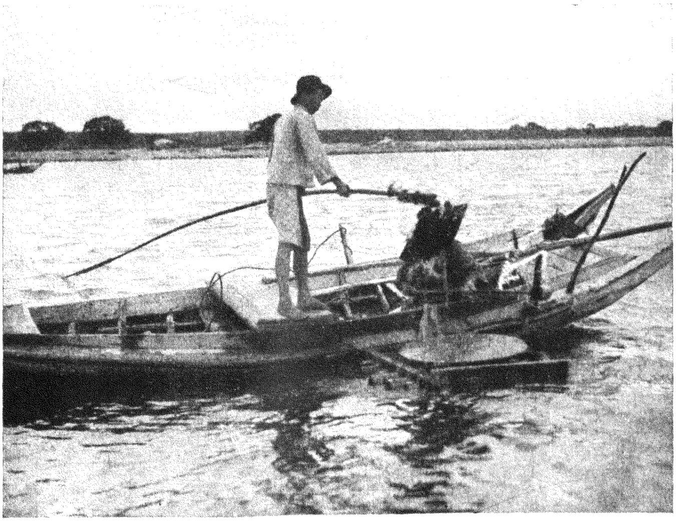

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PLATE 3.

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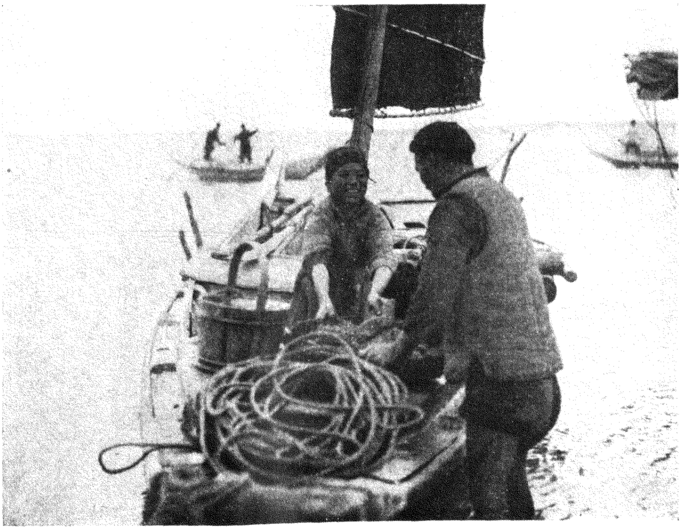

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PLATE 4.

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PLATE 5.

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FILING AND BLACKENING OF TEETH AMONG SOME PHILIPPINE ETHNIC GROUPS

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TWO PLATES

This paper describes some of the methods of filing and blackening of the teeth, a practice adhered to by various Philippine ethnic groups. This odd practice may be due to a tribal conception of beauty or may merely be the continuation of an ancient means of preserving the teeth. Some of these groups, like the Bagobos, both file and blacken their teeth; the Negritos merely file them to points; while others, like the Kalingas, only blacken them.

The first part of the present paper deals with filing the teeth, while the second part deals with the method of blackening them.

FILING THE TEETH

Filing the teeth into points or filing their front surfaces concave was widely practiced formerly by nearly all of the known ethnic groups in the islands.

Worcester,[1] speaking of the filing of the teeth by the Negritos of Zambales, says that it is a widespread custom among this ethnic group to have the front teeth pointed. The operation is performed in the following manner: A piece of wood is placed back of the tooth to be operated on, the point of a bolo is firmly pressed against the front surface of the tooth, and the bolo is struck with a sharp blow with a stick or stone, so that the corner of the tooth is chipped off. This process is repeated on the other side of the tooth to produce the desired point.

According to Reed[2] the custom of filing the teeth prevails throughout the entire Negrito region of Zambales. Usually only the upper teeth are treated. However, there were cases where the teeth were sharpened both above and below. Adornment seems to be the sole object of this practice.

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[1] Worcester, Dean C. The Non-Christian tribes of northern Luzon. Philip. Journ. Sci. 1 (1906) 807.

[2] Reed, William Allan. Negritos of Zambales. In Ethnological Survey Publications pt. 1 2 (1904) 36.

The sharpening of the teeth is performed by placing the blade of a bolo against the part of the tooth to be chipped off and giving it a sharp blow with a piece of wood. The operation is locally known as *talihan.* It is a rather delicate process, for it requires care to prevent breaking through into the soft part of the tooth and exposing the nerve. Although the teeth are mutilated, they seem to be well preserved.

Cole [3] states that both men and women of the Bagobos on the west coast of Davao Gulf file their teeth. When a boy or girl has attained puberty, it is time to beautify the teeth. There is however, no prohibition from having it done earlier. The patient places his head against the operator and grips a stick of wood between his teeth while each tooth is filed to a point. (Plate 1, fig. 1) When this operation has been completed what is left is blackened.

According to Christie [4] it is very common among the Subanuns of Sindañgan Bay to grind down some of their teeth. The teeth selected are the upper front teeth, including the two canines. The effect aimed at is the sharpening of the latter and the hallowing out on the anterior surface of the former so as to produce a concave appearance. The grinding is done with a stone. There is no fixed period for the process of grinding, but it is usually done when the patient is well grown. The grinding is done gradually. The teeth operated on are commonly blackened after grinding.

According to Garvan,[5] among the Manobos both boys and girls have their teeth ground at puberty. The process of grinding the teeth is very simple but extremely painful. A piece of wood is inserted between the teeth to keep them apart. The operator then inserts a small piece of sandstone into the mouth, and with a moderate motion grinds the upper and lower incisors to the gum. After filing, the teeth of the upper jaw appear convex and those of the lower, concave. It takes 3 to 10 days to grind the teeth.

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[3] Cole, Fay-Cooper. The Wild Tribes of Davao District, Mindanao. In Field Museum of Natural History (2) 12 (1913) 60.

[4] Christie, Emerson Brewer. The Subanuns of Sindañgan Bay. In Division of Ethnology Publications pt. 1 **6** (1909) 52, 53.

[5] Garvan, John M. Mem. Nat. Sci. **23** (1931) 55.

Colin[6] says that "the ethnographic groups who are now civilized formerly had the custom from infancy to file their teeth so that they may be even and pretty."

Bobadilla[7] states that "among the Bisayans, the teeth were filed from their earliest childhood. Some were made even, and others were filed to points which give them the appearance of a saw."

Chirino[8] also says that "among the Bisayans, the teeth were filed and sharpened from early childhood either leaving them uniform or fashioning them all to a point, like a saw. This matter was not practiced by the higher class of people."

Morga[9] states that among the Sambals the teeth were filed and made even with stone and iron from a very early age.

BLACKENING THE TEETH

The practice of blackening the teeth likewise was formerly widespread, although the Negritos and a few other pagan groups of northern Luzon do not follow it. The majority of the pagan and Mohammedan groups of Mindanao, however, generally blacken their teeth, to beautify and preserve them.

Although among a good number of Kalingas this custom is obsolete, there are still a few, particularly those living in the outlying districts, who adhere to it. Among males teeth-blackening is usually done at the age from 14 to 21; among the females, usually at puberty. Like the other groups, the Kalingas blacken the teeth to beautify and preserve them.

The material used is the black resinous substance from dried guava bark, burnt and rubbed against the *landuc* or *babalasigan,* an iron implement where the substance is accumulated. Before the subject retires, the black resinous substance is heated and rubbed with the fingers on the teeth until they are entirely black. Because of the unpleasant taste of this blackening agent, it is not widely used and has fallen into disfavor. This practice is usually observed at least once a week, or as often as the black color of the teeth fades. This method of blackening is known as *tubug* among the Mañgali-Lubo group, and as *beasig* among the Lubuagan groups.

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[6] Colin, Francisco. Native Races and their Customs. In Blair, Emma Helen, and James Alexander Robertson. The Philippine Islands 1493–1898. 40 (1906) 60, 61.

[7] Bobadilla, Diego de. Relation of the Filipinas Islands. In Blair, Emma Helen, and James Alexander Robertson. The Philippine Islands 1493–1898 40 (1904) 287.

[8] Chirino, Pedro. Relation of the Filipinas Islands. In Blair, Emma Helen, and James Alexander Robertson. The Philippine Islands 1493–1898 40 (1904) 187.

[9] Morga, Antonio de. Sucesos de las Islas Filipinas. In Blair, Emma Helen, and James Alexander Robertson. The Philippine Islands 1493–1898 16 (1904) 78.

Cole,[10] who made a study of the Tinggians of Abra, states that both men and women blacken the teeth with iron salts and tan bark.

De los Reyes, speaking of the Tinggians of Abra, says that "Los Tinguianes se tiñen de negro los dientes."[11]

According to Cole [12] the color for blackening the teeth of the Bagobos is obtained in two ways. The common method is to place a piece of metal on one end of a bamboo tube, made of a variety of bamboo known as *balakáyo,* with one end resting on glowing coals. The smoke from the charring bamboo is conducted through the tube to the metal on which it leaves a deposit or 'sweat.' This is rubbed on the teeth, at intervals, until they become shiny black.

In a second method a kind of powder, known as *tapel,* is used. Tapel is secured from the *lamod* tree. The powder is wrapped in leaves and chewed. During this period of treatment the patient is under certain restrictions. He is not allowed to drink water, cook, or eat anything sour. He should not attend funerals. Should he do so, his teeth will have a poor color or he himself will be sick. When the teeth have been properly blackened the young man or woman is considered ready to enter society.

According to Garvan,[13] among the Manobos blackening of the teeth is effected principally by the use of a plant called *máu-máu* which, besides being used as a narcotic, has the property of giving the teeth a rather dark color. After being chewed it is rubbed across the teeth to make the coloring uniform. The constant use of betel leaf with lime is another means of staining the teeth.

---

[10] Cole, Fay-Cooper. The Tinggian. Philip. Journ. Sci. § A 3 (1908) 201.

[11] De los Reyes y Florentino, Isabelo. Articulos Varios (1887) 10.

[12] Cole, Fay-Cooper. The Wild Tribes of Davao District, Mindanao. In Field Museum of Natural History Publications 12 (1913) 60, 61.

[13] Garvan, John M. Mem. Nat. Acad. Sci. 23 (1931) 55.

Christie[14] says that after the teeth of the Subanuns are ground even, it is a common practice to blacken them. One substance used for this purpose is lime juice or some other acidic liquid in which iron has been allowed to dissolve. The resultant solution is rubbed on the surface of the teeth. There is no fixed period for the process of staining, but it may be said to be usually done when the patient is well grown.

Blackening of the teeth is practiced very extensively among the Sulu Moros. The teeth are dyed black with antimony, a mineral stibnite.

Bobadilla[15] states that the ancient Bisayans covered their teeth with either a black, or a flame-colored, glossy polish. Thus their teeth become black or vermillion red, as the case may be. Small openings are made in the upper row, which are filled with gold which shows to advantage on the black or red background of the polishing material.

According to Chirino[16] the ancient Bisayans covered their teeth with varnish, either lustrous black or bright red, with the result that the teeth remain as black as jet, or ruby or vermillion red. From the edge to the middle of the tooth they neatly bore a hole, which they afterward fill with gold, so that this point of gold remains as a shining spot in the middle of the black tooth. Teeth treated in this manner are regarded by them as a mark of beauty.

SUMMARY

The practice of filing the teeth was formerly almost universal among ethnic groups in the Philippines. The practice has now lost favor, but a few tribes still adhere to it, among them the Negritos, Bagobos, Manobos, and Subanuns.

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[14] Christie, Emerson B. The Subanuns of Sidañgan Bay. In Division of Ethnology Publications pt. 1 6 (1909) 52, 53.

[15] Bobadilla, Diego de. Relation of the Filipinas Islands. In Blair, Emma Helen, and James Alexander Robertson. The Philippine Islands 1493–1898. 29 (1904) 287, 288.

[16] Chirino, Pedro. Relation of the Filipinas Islands. In Blair, Emma Helen, James Alexander and Robertson. The Philippine Islands 1493–1898. 22 (1904) 187.

Likewise the practice of blackening the teeth was formerly widespread. Some pagan groups of northern Luzon—the Kalingas and Tin̄ggians and the majority of the pagans and Mohammedans of Mindanao—Bagobos, Manobos, Subanuns, and Sulu Moros—cling to the custom with stubborn tenacity.

The idea of filing and blackening of the teeth may be due to an endemic conception of beauty or may be merely a perpetuation of an ancient type of dental prophylaxis.

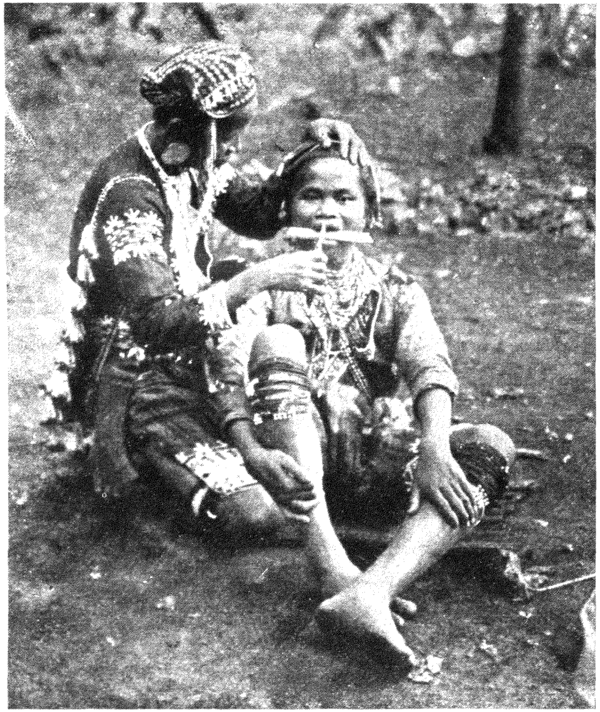
ILLUSTRATIONS

PLATE 1

FIG. 1. A Bagobo young man having his teeth filed or cut to points.
2. A Bagobo man showing his pointed upper teeth.

PLATE 2

FIG. 1. A Negrito man from the mountains of Pampanga, showing his pointed teeth.
2. A Moro datu of Jolo, showing his blackened teeth.
3. Iron instruments (babalasigan) used by the Kalingas in blackening the teeth.



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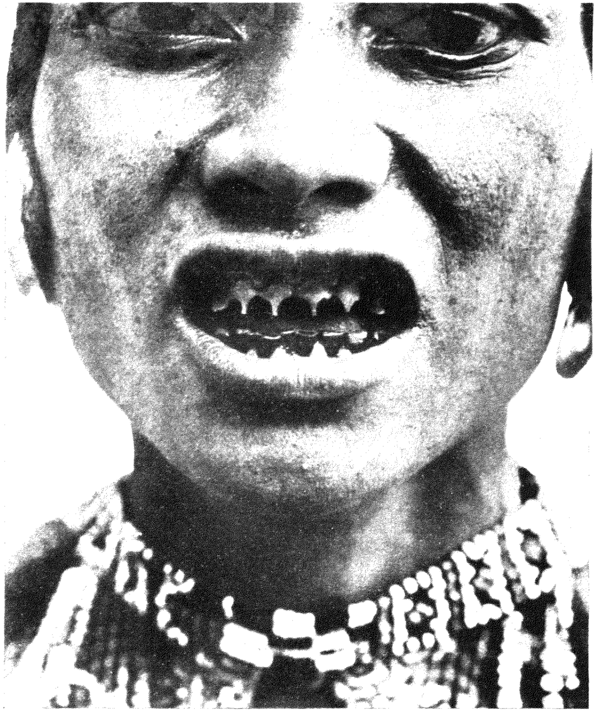

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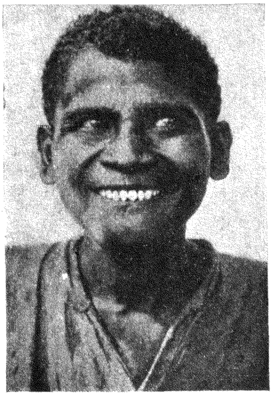

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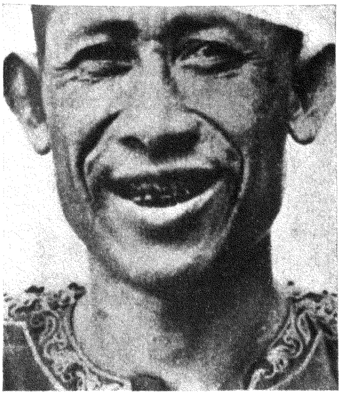

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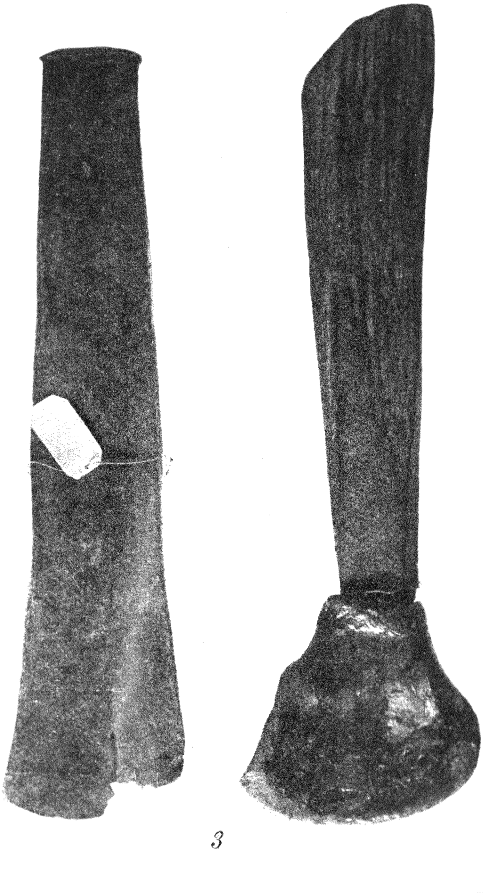

3

PLATE 2.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Race, Language and Culture. By Franz Boas. New York, The Macmillan Co., 1940. 647 pp., illus. Price, $5.

Race, Language and Culture is a recent anthropological work, composed of the author's collected writings, dealing principally with the physical and social aspects of anthropology. It is divided into the three main topics indicated by the title. Also appended are miscellaneous topics on the methods of teaching anthropology, the aims of ethnology, and the study of geography.

In his chapters on race the author refers to biological and sociological problems due to the intermingling of racial types. He dwells on the modern population of America and its heterogeneity, on heredity, on the influence of environment, on selection, on racial and individual differences, and on eugenics. He formulates problems and proposes investigations. He also discusses the anthropological study of children and the study of anthropometry. His main object is to determine how the physical development of a given individual compares with the average physical development of the group to which he belongs. There is also included a critical review of the works of authors dealing with the methods of physical anthropometry.

The author devotes a goodly number of pages to the study of American aboriginal languages and their classification. He particularly mentions some characteristics of the Dakota languages and the metaphor of the Kwakiutl tribe. He gives a brief exposition of facts relative to the aims of anthropological research and the methods of cultural anthropology. He likewise discusses the origin of totemism, the history of the American race, ethnological problems in Canada, the social organization of the Kwakiutl society and North Pacific Coast tribes, the development of folktales and myths, the growth of Indian mythologies, and the idea of future life among primitive tribes.

He advocates the inclusion of anthropology in the University curriculum and sets forth the aims of ethnology. He discusses the total range of the phenomena of social life. The last topic treats of the value of geography in research.

In this book the author gives, in clear, concise form, a freer and more independent view of the study of man. He cites, too, the relation which such study bears to everyday problems.

Every student of anthropology should read this book.

—R. E. G.

Chemistry in Warfare; Its Strategic Importance. With a Foreword by Crosby Field and a Technical Appendix. By Frederick A. Hessel, M. S. Hessel and W. J. Martin. New York, Hastings House, 1940. 164 pp., illus. Price, $2.

This book is so far the latest work on the rôle of chemistry in warfare, including the present world conflict. It contains valuable information for the enlisted man, the chemist, and the layman. It gives a vivid picture of how wars are fought at the front, in the factories, and in the research laboratories. It explains why no nation today can afford to be without an active chemical industry and chemists equipped to meet any emergency.

It illustrates the rôle of the chemist in keeping an army in fighting condition by the proper supply of food, clothing, and shelter. It explains how weapons, both defensive and offensive, are adequately supplied with projectiles, propellants, and high explosives. It tells how troops, as well as civilians, are fitted out with gas masks and other protective equipment.

It gives a brief but nevertheless thorough outline of the development of modern armaments. The information obtained from this books enables the layman to understand the technical names of poison gases, explosives, and other military equipment about which he reads daily in the newpapers.

The book is divided into five chapters. It contains an appendix on the technical processes used in the manufacture of the principal war materials. It also contains a selected bibliography on the subject.—F. A.

Chemicals of Commerce. By Foster Dee Snell and Cornelia T. Snell. New York, D. Van Nostrand Co., Inc., 1939. 542 pp. Price, $5.

Many books have been written that deal with chemistry and chemicals for the layman. Chemicals of Commerce is one of the books that deserves special attention. Thirty-seven chapters cover all the chemicals most frequently used in commerce. The grouping of allied chemicals by chapters gives the reader a bird's-eye view of the different products included without resorting to other references. In the appendices are included: The United States Caustic Poison Act; Summary of the Food, Drug and Cosmetic Act; and definitions of medical terms used in the book.

The authors should be commended for putting into book form and in simple language a great deal of information about formulas, uses, and properties of chemicals that is usually available only to a selected group of chemists.

Written in a popular style, the book is very useful and should be on the bookshelf of those engaged in chemistry and others who seek information about the thousand and one chemicals of commerce.—G. O. O.

May's Chemistry of Synthetic Drugs. By Percy May and G. Malcolm Dyson. Fourth Edition, Revised and Rewritten. London—New York —Toronto, Longmans, Green and Co., 1939. 370 pp., illus. Price, $6.

As stated in the preface, this book contains an account of the main facts concerning the nature of synthetic drugs and the guiding principles which are used in their production.

It also calls attention to reactions taking place between the drug and the living organism whenever these can be traced. Consideration is also given to the relation between the chemical character of a substance and its pharmacological action, even though this relation is neither so complete nor so simple as might be desired.

Included in this new edition are the recent advances in the chemistry of hormones, vitamins, sulfonamide derivatives, synthetical ureas, and organometallic compounds.

This book is standard in the line of synthetic drugs, and the fourth edition is characterized by the same excellence as the former editions.—A. O. C.

Chemotherapy and Serum Therapy of Pneumonia. By Frederick T. Lord, Elliott S. Robinson, and Roderick Heffron. New York, The Commonwealth Fund, 1940. 174 pp., illus. Price, $1.

This little book is in the main a description of the work done by the Massachusetts Department of Public Health. The presentation of the facts, the arrangement of the topics, and the principal purpose seem to be to furnish the general practitioner with a manual to guide him in the treatment of pneumococcus pneumonia.

A few paragraphs are devoted to the discussion of pneumonia as a community problem, to definitions, and to diagnosis. The greater part of the book is given to data about the use of sulfapyridine and of immune serum. Detailed information about the indications of these two therapeutic aids, the contraindications, the manner of administration, the posology, and the untoward reactions and their treatment are given. In appendix C an instruction sheet intended for physicians regarding the use of sulfapyridine and antiserum is attached. The sheet gives a summary of when to use the drug alone, when to use the serum alone, and when to use both. The manner of adjusting dosage, the warnings about toxic manifestations, and when to discontinue serum therapy are indicated.

Various other procedures necessary in the treatment of pneumonia, and which the general practitioner can make use of, are also discussed in detail. The Neufeld method of typing, the Francis skin test, the different tests for sensitivity, and the step by step directions for administering serum are also described.

A comparison of the results obtained with the two ways of treating pneumonia is made. But the different tables and figures are now somewhat out of date because so rapid and widespread has been the use of the different sulfanilamide compounds that the results of different workers published in journals quickly supersede those found in books, even if these be only a few months old. The book is not intended for the research worker or investigator, because the author has not brought out anything new or provocative. It is primarily for the use of the practitioner who would like a manual of instructions that is practical, brief, and comprehensive.—A. B. R.

Photo-Lab-Index. The Cumulative Formulary of Standard Recommended Photographic Procedures. By Henry M. Lester. New York City, Morgan & Lester, 1939. 288 pp. Price, $3.50.

Photo-Lab-Index is a compilation of the old and the new findings in the science of photography. It is a sort of a photo vocabulary for the amateur and professional photographers. Being very handy as a reference, this book will help a great deal in understanding the new and modern methods employed in photography. Different photo manufacturers are publishing quarterly improvements of their film papers and formulas for developers. Workers in photography should be well informed in the new procedures so as to keep them abreast of the modern trend in photography.

This book is highly recommended to anyone interested in photography.—C. S. A.

Conserving Our Resources. By Edward E. Keso. Oklahoma City, Times-Journal Publishing Co., 1940. 206 pp., illus. Price, $0.98.

This book is a handy, comprehensive volume, written in popular style, on the conservation of natural resources. It seems primarily intended for use in schools below the collegiate rank and, although the discussions generally refer to American resources and conditions, it will be a very valuable reference book in all of our school libraries. It will relieve us who are actually and actively engaged in the work of administering, developing and conserving our own natural heritage, of much of the educational phase of conservation. Thus we shall be able to concentrate our attention on the tasks of solving the numerous problems that arise from the growing demands of our population upon these resources, and of prolonging, for an indefinite length of time, their availability for prudential use.—S. S. P.

Aids to Goatkeeping. By Corl A. Leach. Third edition. Fairbury, Nebraska, Dairy Goat Journal, 1940. 104 pp., illus. Price, $1.

To the beginner in the raising of dairy goats this book will prove an interesting and valuable reference. Written in simple, concise language, it contains suggestions in choosing a breed; in housing, caring, feeding, and managing does, bucks, and kids. It contains some illustrated descriptions on the proper way to construct dairy goat barns and milk houses, as well as other facilities needed in a dairy goat project.

As in the cattle dairy, the procuring of clean, safe, sanitary milk and the keeping of production records are emphasized in this book. The causes of ill-flavored milk and the means to preclude or avoid them are given.

Udder troubles, ailments, and parasites commonly observed in goats are treated lengthily in this book. The author enumerates in plain terms the most common symptoms of these maladies, and simple remedies for eradicating them. He emphasizes the need of consulting a qualified veterinarian, whenever available, in handling these diseases.

Finally, the author states that "there is no greater aid to goat keeping than the common sense of the goat keeper." In order to succeed, he suggests that a goat keeper should keep a vigilant eye on the needs of the animals; exercise his careful judgment and consideration in the application of suggestions and instructions; come in contact with and consult other goat owners; and avail himself always of the benefits derived from the study of periodicals and writings of others pertaining to the dairy goat.—G. S. A.

Principles of Dairy Goat Selection. By Corl A. Leach. Fairbury, Nebraska, Dairy Goat Journal, 1940. 56 pp., illus. Price, $1.

The books is an exposition of the principles underlying the selection of dairy goats, on the basis of type, production, and pedigree. The author claims that very few goats possess pedigrees or papers of registry, and for this reason lays emphasis on selection based on type. A discussion on the relationship of form to production is given in detail. Score cards for judging the utility goat and the most important breeds of dairy goats are also included. Illustrations form part of the text. As the author puts it, "the principles outlined herein are but principles . . . Should any breeder consider the suggestion given here as final and conclusive, the book will not only lose its value but can defeat its own purpose. But if regarded as a guide book, explaining the signs where-by the breeder can proceed as his own judgment dictates, then these principles will become a practical guide to increasing the excellence of the breed." —G. S. A.

1940 Yearbook of the American Goat Society, Incorporated. University Place Station, Lincoln, Nebraska, The Society, 1940. 237 pp., illus. Price, $1.

The yearbook contains a history of the American Goat Society, Incorporated. It contains splendid articles on dairy goats such as, Why a Purebred Sire? by Ira J. Mills, Twenty-Five Years With Purebred Goats by W. D. Stambaugh, Artificial Insemination in Goats by L. M. Winters, and others by well-known authors. It also includes the Constitution, The Bylaws, Rules, and Regulations of the American Goat Society. Registration of some of the most popular breeds of dairy goats, such as the French Alpine, Nubian, Saanen, and Toggenburg forms part of the yearbook. It is profusely illustrated, and ably edited by Will H. Chappel, President of the American Goat Society, Incorporated.—G. S. A.

RECEIVED

BISHOP, GGRACE M. You and your food. London, The C. W. Daniel co., ltd., 1939. 45 pp. Price, paper, 1s/–.

BROUGH, JAMES. The triassic fishes of Besano, Lombardy. Printed by order of the trustees of the British Museum, London, 1939. 117 pp., plates, illus. Price, £1.

FRAPRIE, FRANK R., ED. How to make lantern slides. Practical photography, no. 7. Boston, American photographic publishing co., 1940. 80 pp., illus.

HAWKINS, HAROLD F. Applied nutrition. Gardena, California, Institute press, 1940. 195 pp., illus. Price, $3.

JACOBSON, C. I. Developing: the negative technique (Manual of phototechnique, no. 2). London and New York, The focal press, 1940. 287 pp., llus. 10s/6d.

MARBLE, PRISCILIA R. Home safety. New York, American book co., 1940. 144 pp., illus. Price, $0.80.

READ, BERNARD E., and W. WAGNER. Shanghai vegetables. Shanghai, The China-Journal publishing co., ltd., 1940. 31 pp., plates.

SMITH, KENNETH M. The virus: life's enemy. New York, The Macmillan co. Cambridge: At the university press, 1940. 176 pp., illus., front. Price, $2.

ERRATA

VOLUME 74, NO. 3

Page 247, last paragraph, line 6: *For* on *read* one.

Page 258, caption of Table 5 should read: *Effect of the time of contact of grated coconut meat with water on efficiency of oil extraction*—continued.

Page 275, line 15 should read: One gas producer engine, 250 H. P., with motor.

VOLUME 75, NO. 2

Illustrations of the article "Notes on the orchid bug, Mertila malayensis Distant, on white mariposa (Phalaenopsis amabilis Blume)," by Santiago R. Capco: *For* Plate 1 *read* Plate 2, and *for* Plate 2 *read* Plate 1.

According to a letter received September 12, 1941, from Prof. H. H. Knight, of Iowa State College, the orchid bug described in Capco's article is *Mertila brevicornis* Poppius (Tijdschr. v. Ent. Suppl. **56** [1914] 154) and not *Mertila malayensis* Distant.

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